RECD 7-11-96

Regional Remediation Team

Monthly Progress Report No. 72

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Pursuant to: RCRA I-88-1088

Facility Site: Cranston, RI

Period Covered: June 1996 (June 1, 1996 - June 28, 1996) through fourth Friday of the month.

Date Submitted: July 9, 1996

1.0 SUMMARY

This is the seventy second monthly progress report. There were four areas of significant activity this month:

- **Stabilization IRM** - The groundwater extraction wells 110 and 120 and the pretreatment system continued to operate during June with no problems. The Soil Vapor Extraction (SVE) System still has not become operational. (see 3.0)

- **Sediment Removal IRM** - The revision of this report is still not complete but should be submitted to EPA by mid-July. It has been held up by other efforts. (see 4.1)

- **On-Site IRM** - Ciba proposed to remove an additional 45 to 60 cu yd. of PCB contaminated soil from SWMU#5 in early July to complete this IRM for the Warwick Property. (see 4.2)

- **Pawtuxet River CMS Report** - Ciba and its consultants started work on the CMS report in mid-April. We anticipate preparation of a **"focused"** report similar to the On-Site CMS, where only 3-4 alternatives will be considered for evaluation/selection. (see 4.3)

2.0 TASKS AND ACTIVITIES COMPLETED

All tasks and activities were still underway in June.

3.0 JEOPARDY TASKS

The reprogramming of the operating software for the Soil Vacuum Extraction (SVE) system was completed in June and the system was test run. However, the catalyst used in the gas fired oxidation unit was not performing properly, resulting in odors and the unit was shut down after 24 hr. The catalyst supplier has indicated this is a relatively simple operating problem to fix. Ciba anticipates, therefore, that the SVE will be fully operational in July. It should be noted that automatic sensors for the dual phase wells and the safety shut offs, which were the primary software concerns, operated well, however, we are concerned whether the vacuum system can pump the groundwater level down effectively.

4.0 OTHER TASKS UNDERWAY

The following activities and tasks are underway.

4.1 Pawtuxet River CMS

The removal of the contaminated sediments from the area of the former Cofferdam was completed during the fall/winter of 1995. A detail Sediment IRM report has been prepared, including a photographic log. While this report has been delayed by other priority activities for the Cranston Site, Ciba proposes to submit it by mid-July.

4.2 SWMU #5

In June, EPA expressed concern about the potential risk to future residents of the Warwick Property from elevated levels of PCBs remaining at several locations below two (2) ft. depth in the northwest corner of SWMU#5 after completion of the on-site soil removal IRM. In response, Ciba proposed to remove approximately 45-60 cu yd. of soil in the small spot from the two (2) ft. depth to the water table, about 4.5 ft. The EPA approved this activity on June 20th. The spot removal is scheduled for July 8 - 10. The appropriate sections of the On-Site IRM and the On-Site CMS reports will be revised to incorporate this minor removal. They will be resubmitted to EPA by July 31st.

4.3 PAWTUXET RIVER CMS

Ciba is continuing the preparation of the Pawtuxet River CMS for submittal to EPA by August 16. In discussions with the EPA on June 28th, Ciba indicated that Media Protection Standards (MPS) are being considered only for the volatile organic compounds occurring in the Production Are groundwater to protect the benthic organisms in the river. The proposed Point(s) of Compliance (POC) would be the in-river monitoring wells (SW-110, 120 and 130). The actual MPS would be the Toxicity Reference Values (TRVs) established for these organisms in the Ecological

Risk Assessment Report, Vol. III of the Pawtuxet River RFI. Also, since this report concluded that the Sediment IRM had completed the remediation for Ciba related compounds in the river and that the ecological risk remaining, upstream, in the Facility Reach, and downstream, was due to ubiquitous, non-site compounds, such as PAHs, metals, and phenol, Ciba will not be proposing MPS for the sediment itself. The CMS report will include recommendations for future groundwater and sediment monitoring.

5.0 DATA OBTAINED

Several reports and results were submitted to Ciba in June by our consultants as follows:

5.1 GROUNDWATER MONITORING

The groundwater in the Production Area was sampled and re-sampled by Ciba at 17 monitoring wells in March and April, respectively, as shown in Attachment 1. The results of both samplings indicate that volatile organic compounds (VOC) have declined significantly from the 1991/92 Phase II measurements (see Table 2-2). Also, semi-volatiles including PAHs and metals are essential at background levels and are not a concern. These recent volatile results will be used in the river CMS to benchmark the MPS and establish cleanup times for the groundwater extraction alternative.

5.2 CONTAMINANT MASS INCEPTION

Woodward Clyde prepared a detailed letter report which established the contaminant mass capture provided by the two extraction wells (PW-110 and 120) at 96% for the six volatile organic compounds occurring in the Production Area groundwater. The report indicates that, while the gradient has not been reversed along the entire bulkhead, the capture rate is so high that the objectives for groundwater extraction in the Stabilization IRM have been met (see Attachment 2).

5.3 LOCATION OF CAPTURE MONITORING WELLS

Woodward Clyde also evaluated the performance of the paired wells in the Production Area and the river used to measure the head reversal (Attachment 3). Pairs MW-10/SW-110 and MW120/SW120 were found to be located in the appropriate aquifers at similar depths. MW130 was found to be shallow and should have been 10 to 15 ft. deeper. However, they did not recommend installing a deeper well since differential head measurements are no longer critical to the stabilization IRM and since the capture rate, as reported in Attachment 2, is 96%. Note, also that the location of the river wells SW-110, 120, 130 are in the appropriate aquifer to represent groundwater flow under the bulkhead and could be used a conservative Point(s) Of Compliance (POC) wells to measure the pore water reaching the surface sediments.

6.0 PROBLEM AREAS

There are no problems, which are not being resolved, in a timely manner.

7.0 SCHEDULE OF TASKS (next two months)

The following tasks will be started, on-going, or completed in July and August.

- Startup the SVE continuously (July)
- Complete the River CMS Report (July-August)
- Address PCBs Remaining at SWMU #5 (July)

8.0 CHANGES IN WORK PLAN

No changes to the Work Plan are proposed at this time; however, we have requested that the Toxicity Indicator Evaluations (TIES) in the Phase II River Study be eliminated based upon the results of the Aquatic Baseline Ecological Risk Assessment, submitted on March 29..

9.0 OTHER COMMENTS

On June 12, Ciba sent a letter to the Cranston POTW requesting that the groundwater from the two extraction wells be discharged without pretreatment because the organic and metals meet their limits. We expect to implement this minor change in the next several months. Groundwater from the SVE system would continue to be pretreated because of the high toluene levels.

\MNTCRPRO\B

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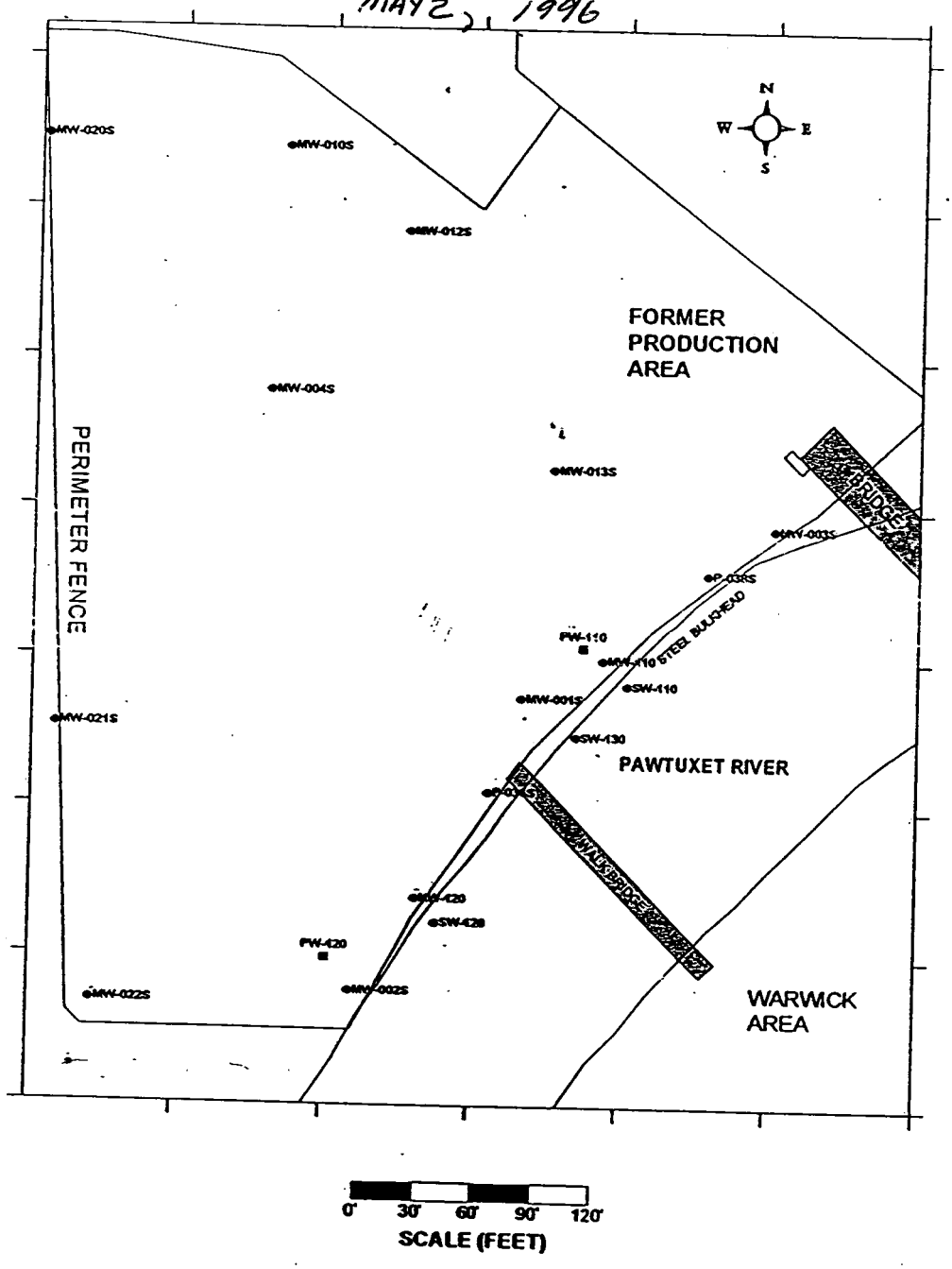
ATTACHMENT 1
GROUNDWATER SAMPLING

CIBA-GEIGY CORPORATION
CRANSTON, RI FACILITY
PRODUCTION AREA

Well Monitoring Locations
For
March 5&6, 1996
MAY 2, 1996



Legend

- ● Monitoring Well
- ■ Production Well

Figure 1

TABLE 2-1
SAMPLE ANALYSIS SUMMARY
CRANSTON SITE
PRODUCTION AREA
SHALLOW MONITORING WELLS

Monitoring Well Number	Location	Type	Sample Analyses	Justification
MW-1S	Production Area AOC-13	Shallow Monitoring Well	VOCs by USEPA Method 624 Total Cyanide by USEPA Method 335.2 Pesticides (including methyl parathion) and PCBs by USEPA Method 608 Semi-VOCs (including 4-chloraniline) by USEPA Method 625 Total Metals (cadmium, chromium, copper, lead, nickel, silver, zinc, cobalt, and berrylium) by USEPA Method 200.7	Monitoring well along bullhead will provide data on groundwater up-welling to the Pawtuxet River sediments
MW-2S	Production Area AOC-13	Shallow Monitoring Well	VOCs by USEPA Method 624 Total Cyanide by USEPA Method 335.2 Pesticides and PCBs by USEPA Method 608 Total Metals (cadmium, chromium, copper, lead, nickel, silver, and zinc) by USEPA Method 200.7	Monitoring well where surficial soils have PCBs
MW-3S	Production Area AOC-13	Shallow Monitoring Well	VOCs by USEPA Method 624 Total Cyanide by USEPA Method 335.2 Total Metals (cadmium, chromium, copper, lead, nickel, silver, and zinc) by USEPA Method 200.7	
MW-4S	Production Area AOC-13	Shallow Monitoring Well	VOCs by USEPA Method 624 Total Cyanide by USEPA Method 335.2 Total Metals (cadmium, chromium, copper, lead, nickel, silver, and zinc) by USEPA Method 200.7	
MW-10S	Production Area AOC-13	Shallow Monitoring Well	VOCs by USEPA Method 624 Total Cyanide by USEPA Method 335.2 Total Metals (cadmium, chromium, copper, lead, nickel, silver, and zinc) by USEPA Method 200.7	
MW-12S	Production Area AOC-13	Shallow Monitoring Well	VOCs by USEPA Method 624 Total Cyanide by USEPA Method 335.2 Total Metals (cadmium, chromium, copper, lead, nickel, silver, and zinc) by USEPA Method 200.7	
MW-13S	Production Area AOC-13	Shallow Monitoring Well	VOCs by USEPA Method 624 Total Cyanide by USEPA Method 335.2 Total Metals (cadmium, chromium, copper, lead, nickel, silver, and zinc) by USEPA Method 200.7	
MW-20S	Production Area AOC-13	Shallow Monitoring Well	VOCs by USEPA Method 624 Total Cyanide by USEPA Method 335.2 Pesticides and PCBs by USEPA Method 608 Total Metals (cadmium, chromium, copper, lead, nickel, silver, and zinc) by USEPA Method 200.7	Monitoring well where surficial soils have PCBs
MW-21S	Production Area AOC-13	Shallow Monitoring Well	VOCs by USEPA Method 624 Total Cyanide by USEPA Method 335.2 Pesticides and PCBs by USEPA Method 608 Total Metals (cadmium, chromium, copper, lead, nickel, silver, and zinc) by USEPA Method 200.7	Monitoring well where surficial soils have PCBs
MW-22S	Production Area AOC-13	Shallow Monitoring Well	VOCs by USEPA Method 624 Total Cyanide by USEPA Method 335.2 Total Metals (cadmium, chromium, copper, lead, nickel, silver, and zinc) by USEPA Method 200.7	
MW-110 (P-37S)	Production Area AOC-13	Shallow Piezometers	VOCs by USEPA Method 624 Total Cyanide by USEPA Method 335.2 Pesticides (including methyl parathion) and PCBs by USEPA Method 608 Semi-VOCs (including 4-chloraniline) by USEPA Method 625 Total Metals (cadmium, chromium, copper, lead, nickel, silver, zinc, cobalt, and berrylium) by USEPA Method 200.7	Monitoring well along bullhead will provide data on groundwater up-welling to the Pawtuxet River sediments
MW-120 (P-35S)	Production Area AOC-13	Shallow Piezometers	VOCs by USEPA Method 624 Total Cyanide by USEPA Method 335.2 Pesticides (including methyl parathion) and PCBs by USEPA Method 608 Semi-VOCs (including 4-chloraniline) by USEPA Method 625 Total Metals (cadmium, chromium, copper, lead, nickel, silver, zinc, cobalt, and berrylium) by USEPA Method 200.7	Monitoring well along bullhead will provide data on groundwater up-welling to the Pawtuxet River sediments
P-36S	Production Area AOC-13	Shallow Piezometer	VOCs by USEPA Method 624 Total Cyanide by USEPA Method 335.2 Total Metals (cadmium, chromium, copper, lead, nickel, silver, and zinc) by USEPA Method 200.7	
P38-S	Production Area AOC-13	Shallow Piezometer	VOCs by USEPA Method 624 Total Cyanide by USEPA Method 335.2 Total Metals (cadmium, chromium, copper, lead, nickel, silver, and zinc) by USEPA Method 200.7	
SW-110 (MW-29S)	Pawtuxet River Upper Facility Reach	Shallow Stilling Well	VOCs by USEPA Method 624 Total Cyanide by USEPA Method 335.2 Pesticides (including methyl parathion) and PCBs by USEPA Method 608 Semi-VOCs (including 4-chloraniline) by USEPA Method 625 Total Metals (cadmium, chromium, copper, lead, nickel, silver, zinc, cobalt, and berrylium) by USEPA Method 200.7	Monitoring well along bullhead will provide data on groundwater up-welling to the Pawtuxet River sediments
SW-120 (MW-31S)	Pawtuxet River Upper Facility Reach	Shallow Stilling Well	VOCs by USEPA Method 624 Total Cyanide by USEPA Method 335.2 Pesticides (including methyl parathion) and PCBs by USEPA Method 608 Semi-VOCs (including 4-chloraniline) by USEPA Method 625 Total Metals (cadmium, chromium, copper, lead, nickel, silver, zinc, cobalt, and berrylium) by USEPA Method 200.7	Monitoring well along bullhead will provide data on groundwater up-welling to the Pawtuxet River sediments
SW-130 (MW-30S)	Pawtuxet River Upper Facility Reach	Shallow Stilling Well	VOCs by USEPA Method 624 Total Cyanide by USEPA Method 335.2 Pesticides (including methyl parathion) and PCBs by USEPA Method 608 Semi-VOCs (including 4-chloraniline) by USEPA Method 625 Total Metals (cadmium, chromium, copper, lead, nickel, silver, zinc, cobalt, and berrylium) by USEPA Method 200.7	Monitoring well along bullhead will provide data on groundwater up-welling to the Pawtuxet River sediments

TABLE 2-2
CRANSTON SITE
PRODUCTION AREA
SHALLOW GROUNDWATER ORGANIC DATA

	SUB AREA	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13
	SAMPLE ID	MW-1S	MW-1S	MW-2S	MW-2S	MW-3S	MW-3S	MW-4S	MW-4S	MW-10S	MW-10S	MW-12S	MW-12S	MW-13S	MW-13S	MW-20S	MW-20S	MW-21S	MW-21S	MW-22S	MW-22S	MW-110(P-37S)
	COLLECT DATE	3/6/96	5/1/96	3/5/96	4/30/96	3/6/96	5/2/96	3/6/96	5/1/96	3/5/96	4/30/96	3/5/96	5/2/96	3/6/96	5/1/96	3/5/96	4/30/96	3/6/96	5/1/96	3/5/96	4/30/96	3/6/96
		Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q
VOLATILE ORGANICS																						
	HALOGENATED																					
624	CHLOROBENZENE	2000	5500	3200	2500	5.7	2.6 J	210	130	1.5 U	1.5 U	2.4 J	1.5 J	7.6	3	1.5 U	1.5 U	15 U	5 J	200	27	900
624	CHLOROFORM	7 U	35 U	35 U	35 U	1.4 U	1.4 U	1.4 U	28 U	2.2 J	2.9	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	14 U	7 U	1.4 U	1.4 U	7 U
624	O-CHLOROTOLUENE	5 U	25 U	25	25 U	13	1 U	1700	120	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	480	820	12	1 J	75
624	TETRACHLOROETHENE	6 U	30 U	30 U	30 U	1.2 U	1.2 U	3.3	24 U	6.3	7.5	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	12 U	6 U	1.2 U	1.2 U	6 U
624	TRANS-1,2-DICHLOROETHENE	5 U	25 U	61	25 U	1 U	1 U	1 U	20 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	10 U	5 U	1 U	1 U	5 U
624	TRICHLOROETHENE	8 U	40 U	40 U	40 U	1.6 U	1.6 U	1.6 U	32 U	1.4 J	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	16 U	8 U	1.6 U	1.6 U	8 U
624	VINYL CHLORIDE	10.5 U	50 U	50 U	27 J	2.1 U	2.1 U	2.1 U	42 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	21 U	10.5 U	2.1 U	2.1 U	10.5 U
624	METHYLENE CHLORIDE	6.6 U	27 J	31.5 U	55 U	1.25 U	2.25 U	1.25 U	22 J	1.25 U	2.25 U	1.25 U	2.25 U	1.25 U	2.25 U	1.25 U	2.25 U	12.5 U	11.5 U	1.25 U	2.25 U	6.6 U
	AROMATICS																					
624	BENZENE	7.3 J	40 U	42 J	40 U	1.6 U	1.6 U	1.4 J	32 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	16 U	8 U	1.6 U	1.6 U	13 J
624	ETHYLBENZENE	28	35 U	27 J	35 U	1.4 U	1.4 U	110	52 J	1.4 U	1.4 U	77	30	5.6	6.4	1.4 U	1.4 U	14 U	15	1.4 U	1.4 U	7 U
624	M&P-XYLENE	18	42.5 U	42.5 U	42.5 U	1.7 U	1.7 U	300	160	1.7 U	1.7 U	75	42	1.7 U	1.8 J	1.7 U	1.7 U	17 U	8.5 U	1.7 U	1.7 U	8.5 U
624	TOLUENE	16	30 J	200	52 J	11	1.4 U	2100	1500	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	12 J	15	1.4 U	1.4 U	7 U
SEMI-VOLATILE ORGANICS																						
	BASE NEUTRALS																					
	PAHs																					
625	ACENAPTHENE	0.7 U	0.75 U	NA	0.7 U	NA	0.75 U	NA	0.7 U	NA	0.75 U	NA	0.7 U	NA	0.7 U	NA	0.7 U	NA	0.7 U	NA	0.7 U	1 J
625	BENZO(A)ANTHRACENE	0.8 U	0.85 U	NA	0.8 U	NA	0.85 U	NA	0.8 U	NA	0.85 U	NA	0.8 U	NA	0.8 U	NA	0.8 U	NA	0.8 U	NA	0.8 U	1.4 J
625	BENZO(A)PYRENE	0.7 U	0.75 U	NA	0.7 U	NA	0.75 U	NA	0.7 U	NA	0.75 U	NA	0.7 U	NA	0.7 U	NA	0.7 U	NA	0.7 U	NA	0.7 U	1.3 J
625	BENZO(K)FLUORANTHENE	1.3 U	1.35 U	NA	1.3 U	NA	1.35 U	NA	1.3 U	NA	1.35 U	NA	1.3 U	NA	1.3 U	NA	1.3 U	NA	1.3 U	NA	1.3 U	1.3 J
625	CHRYSENE	0.8 U	0.85 U	NA	0.8 U	NA	0.85 U	NA	0.8 U	NA	0.85 U	NA	0.8 U	NA	0.8 U	NA	0.8 U	NA	0.8 U	NA	0.8 U	1.4 J
625	FLUORANTHENE	1.1 U	1.15 U	NA	1.1 U	NA	3.3	NA	1.1 U	NA	1.15 U	NA	1.1 U	NA	1.1 U	NA	1.1 U	NA	1.1 U	NA	1.1 U	3.9
625	FLUORENE	0.8 U	0.85 U	NA	0.8 U	NA	0.85 U	NA	0.8 U	NA	0.85 U	NA	0.8 U	NA	0.8 U	NA	0.8 U	NA	0.8 U	NA	0.8 U	1.8
625	NAPHTHALENE	23	34	NA	5.5	NA	0.85 U	NA	3.4	NA	0.85 U	NA	0.8 U	NA	0.8 U	NA	0.8 U	NA	0.8 U	NA	0.8 U	5
625	PHENANTHRENE	0.6 U	0.65 U	NA	0.6 U	NA	0.65 U	NA	0.6 U	NA	0.65 U	NA	0.6 U	NA	0.6 U	NA	0.6 U	NA	0.6 U	NA	0.6 U	2.1
625	PYRENE	0.75 U	0.8 U	NA	0.75 U	NA	2.7	NA	0.75 U	NA	0.8 U	NA	0.75 U	NA	0.75 U	NA	0.75 U	NA	0.75 U	NA	0.75 U	3.2
	PHTHALATES																					
625	BIS(2-ETHYLHEXYL)PHTHALATE	1.05 U	1.1 U	NA	4.8	NA	2.7	NA	9.6	NA	1.1 U	NA	1.05 U	NA	19	NA	1.05 U	NA	16	NA	1.05 U	1.6 J
625	DI-N-BUTYL PHTHALATE	0.8 U	0.85 U	NA	3.3	NA	0.85 U	NA	0.8 U	NA	3.8	NA	0.8 U	NA	0.8 U	NA	3.6	NA	0.8 U	NA	4.1	0.8 U
625	DI-N-OCTYL PHTHALATE	0.8 U	0.85 U	NA	0.8 U	NA	0.85 U	NA	0.8 U	NA	0.85 U	NA	0.8 U	NA	0.8 U	NA	0.8 U	NA	0.8 U	NA	0.8 U	0.8 U
	HALOGENATED																					
625	1,2-DICHLOROBENZENE	1.1 U	0.75 U	NA	28	NA	0.75 U	NA	51	NA	0.75 U	NA	0.7 U	NA	0.7 U	NA	0.7 U	NA	0.7 U	NA	0.7 U	1.2 J
	OTHER BASE NEUTRALS																					
625	NITROBENZENE	4.1	0.9 U	NA	0.85 U	NA	0.9 U	NA	0.85 U	NA	0.9 U	NA	0.85 U	NA	0.85 U	NA	0.85 U	NA	0.85 U	NA	0.85 U	0.85 U
	ACID EXTRACTABLES																					
	PHENOLS																					
625	2-CHLOROPHENOL	25	20	NA	1 U	NA	1.05 U	NA	1 U	NA	1.05 U	NA	1 U	NA	1 U	NA	1 U	NA	1 U	NA	1 U	3.5
625	2,4-DICHLOROPHENOL	0.8 U	0.85 U	NA	0.8 U	NA	0.85 U	NA	14	NA	0.85 U	NA	0.8 U	NA	0.8 U	NA	0.8 U	NA	0.8 U	NA	0.8 U	0.8 U
625	2,4-DIMETHYLPHENOL	1.1 J	1.65 U	NA	1.55 U	NA	1.65 U	NA	1.55 U	NA	1.65 U	NA	1.55 U	NA	1.55 U	NA	1.55 U	NA	1.55 U	NA	1.55 U	1.55 U
625	4-CHLORO-3-METHYLPHENOL	0.9 U	0.95 U	NA	0.9 U	NA	0.95 U	NA	15	NA	0.95 U	NA	0.9 U	NA	0.9 U	NA	0.9 U	NA	0.9 U	NA	0.9 U	0.9 U
625	PHENOL	15	10	NA	39	NA	0.95 U	NA	0.9 U	NA	0.95 U	NA	0.9 U	NA	0.9 U	NA	0.9 U	NA	0.9 U	NA	0.9 U	8.6
	OTHER ACID EXTRACTABLES																					
625	ANILINE	2.5 U	2.6 U	NA	2.5 U	NA	2.6 U	NA	2.5 U	NA	2.6 U	NA	2.5 U	NA	2.5 U	NA	2.5 U	NA	2.5 U	NA	2.5 U	2.5 U
ORGANOCHLORINE PESTICIDES																						
608	DELTA-BHC	0.0045 U	NA	0.0045 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.0045 U	NA	0.0045 U	NA	NA	NA	0.0045 U

All results in ug/l (ppb).

All undetected results listed at half-detection limit.

U - Undetected.

J - Estimated result.

NA - Not analyzed.

TABLE 2-2
CRANSTON SITE
PRODUCTION AREA
SHALLOW GROUNDWATER ORGANIC DATA

	SUB AREA	AOC13		AOC13		AOC13		AOC13		AOC13		AOC13		AOC13		AOC13		AOC13		AOC13		AOC13	
	SAMPLE ID	MW-110(P-37S)		MW-120(P-35S		MW-120(P-35S)		P-36S		P-36S		P-38S		P-38S		SW-110		SW-110		SW-120		SW-120		SW-130		SW-130	
	COLLECT DATE	5/2/96		3/5/96		4/30/96		3/6/96		5/1/96		3/6/96		5/1/96		3/6/96		5/2/96		3/5/96		4/30/96		3/6/96		5/1/96	
		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
VOLATILE ORGANICS																											
	HALOGENATED																										
624	CHLOROBENZENE	770		460		470		440		460		2.4	J	1.2	J	1600		1600		63		70		1.5	U	1.5	U
624	CHLOROFORM	14	U	14	U	7	U	7	U	7	U	1.4	U	1.4	U	14	U	28	U	1.4	U	1.4	U	1.4	U	1.4	U
624	O-CHLOROTOLUENE	29		10	U	5	U	5	U	30		1	U	1	U	55		20	U	1	U	1	U	6.5		12	
624	TETRACHLOROETHENE	12	U	12	U	6	U	6	U	6	U	1.2	U	1.2	U	12	U	24	U	1.2	U	1.2	U	1.2	U	1.2	U
624	TRANS-1,2-DICHLOROETHENE	10	U	10	U	5	U	5	U	5	U	1	U	1	U	10	U	20	U	1	U	1	U	1	U	1	U
624	TRICHLOROETHENE	16	U	16	U	8	U	8	U	8	U	1.6	U	1.6	U	16	U	32	U	1.6	U	1.6	U	1.6	U	1.6	U
624	VINYL CHLORIDE	21	U	21	U	10.5	U	10.5	U	10.5	U	2.1	U	2.1	U	21	U	42	U	2.1	U	8.7		2.1	U	1.2	J
624	METHYLENE CHLORIDE	10	J	12.5	U	11.5	U	6.5	U	11.5	U	1.25	U	2.25	U	12.5	U	45	U	1.25	U	2.25	U	1.25	U	2.25	U
	AROMATICS																										
624	BENZENE	16	U	16	U	8	J	8	U	6.9	J	1.6	U	1.6	U	16	U	32	U	1.7	J	1.8	J	1.6	U	1.6	U
624	ETHYLBENZENE	20	J	14	U	6.6	J	7	U	7	U	1.4	U	1.4	U	19	J	28	U	1.4	U	1.4	U	1.4	U	1.4	U
624	M&P-XYLENE	17	U	17	U	11	J	8.5	U	8.5	U	1.7	U	1.7	U	17	U	34	U	1.7	U	1.7	U	1.7	U	1.7	U
624	TOLUENE	14	U	14	U	7	U	7	U	7	U	1.3	J	1.4	U	460		220		1.4	U	1.4	U	1.4	U	1.4	U
SEMI-VOLATILE ORGANICS																											
	BASE NEUTRALS																										
	PAHs																										
625	ACENAPTHENE	0.75	U	1	J	0.7	U	NA		18		NA		0.75	U	0.7	U	0.7	U	0.75	U	0.7	U	0.7	U	0.75	U
625	BENZO(A)ANTHRACENE	0.85	U	0.85	U	0.8	U	NA		0.8	U	NA		0.85	U	0.8	U	0.8	U	0.8	U	0.8	U	0.8	U	0.85	U
625	BENZO(A)PYRENE	0.75	U	0.75	U	0.7	U	NA		0.7	U	NA		0.75	U	0.7	U	0.7	U	0.7	U	0.7	U	0.7	U	0.75	U
625	BENZO(K)FLUORANTHENE	1.35	U	1.35	U	1.3	U	NA		1.3	U	NA		1.35	U	1.8	U	1.3	U	1.3	U	1.3	U	1.3	U	1.35	U
625	CHRYSENE	0.85	U	0.85	U	0.8	U	NA		0.8	U	NA		0.85	U	0.8	U	0.8	U	0.8	U	0.8	U	0.8	U	0.85	U
625	FLUORANTHENE	1.15	U	1.15	U	1.1	U	NA		1.1	U	NA		1.15	U	1.1	U	1.1	U	1.1	U	1.1	U	1.1	U	1.15	U
625	FLUORENE	0.85	U	0.85	U	0.8	U	NA		10		NA		0.85	U	0.8	U	0.8	U	0.8	U	0.8	U	0.8	U	0.85	U
625	NAPHTHALENE	3.8		18		15		NA		4.8		NA		0.85	U	3.6		8.4		0.8	U	0.8	U	0.8	U	0.85	U
625	PHENANTHRENE	0.65	U	0.65	U	0.6	U	NA		0.6	U	NA		0.65	U	0.6	U	0.6	U	0.6	U	0.6	U	0.6	U	0.65	U
625	PYRENE	0.8	U	0.8	U	0.75	U	NA		0.75	U	NA		0.8	U	0.75	U	0.75	U	0.75	U	0.75	U	0.75	U	0.8	U
	PHTHALATES																										
625	BIS(2-ETHYLHEXYL)PHTHALATE	1.1	U	1.1	U	1.05	U	NA		15		NA		6.2		1.05	U	1.05	U	1.05	U	1.05	U	1.05	U	3.8	
625	DI-N-BUTYL PHTHALATE	1.6	J	0.85	U	4		NA		0.8	U	NA		0.85	U	0.8	U	0.8	U	0.8	U	0.8	U	0.8	U	1.4	J
625	DI-N-OCTYL PHTHALATE	0.85	U	0.85	U	0.8	U	NA		3.7		NA		0.85	U	0.8	U	0.8	U	0.8	U	0.8	U	0.8	U	0.85	U
	HALOGENATED																										
625	1,2-DICHLOROBENZENE	0.75	U	13		12		NA		0.7	U	NA		0.75	U	38		39		0.7	U	0.7	U	0.7	U	0.75	U
	OTHER BASE NEUTRALS																										
625	NITROBENZENE	0.9	U	0.9	U	0.85	U	NA		0.85	U	NA		0.9	U	0.85	U	0.85	U	0.85	U	0.85	U	0.85	U	0.9	U
	ACID EXTRACTABLES																										
	PHENOLS																										
625	2-CHLOROPHENOL	3.5		1.2	J	1	U	NA		5.7		NA		1.05	U	5.4		3.6		1	U	1	U	1	U	1.05	U
625	2,4-DICHLOROPHENOL	0.85	U	0.85	U	0.8	U	NA		0.8	U	NA		0.85	U	0.8	U	0.8	U	0.8	U	0.8	U	0.8	U	0.85	U
625	2,4-DIMETHYLPHENOL	6.6		1.7	J	1.55	U	NA		1.55	U	NA		1.65	U	1.55	U	1.55	U	1.55	U	1.55	U	1.55	U	1.65	U
625	4-CHLORO-3-METHYLPHENOL	0.95	U	0.95	U	0.9	U	NA		0.9	U	NA		0.95	U	0.9	U	0.9		0.9	U	0.9	U	0.9	U	0.95	U
625	PHENOL	4.6		2.8		0.9	U	NA		0.9	U	NA		0.95	U	0.9	U	0.9	U	0.9	U	0.9	U	0.9	U	0.95	U
	OTHER ACID EXTRACTABLES																										
625	ANILINE	2.6	U	2.6	U	2.5	U	NA		2.5	U	NA		2.6	U	21		2.5	U	2.5	U	2.5	U	2.5	U	2.6	U
ORGANOCHLORINE PESTICIDES																											
608	DELTA-BHC	NA		0.0045	U	NA		NA		NA		NA		NA		0.14		NA		0.0045	U	NA		0.0045	U	NA	

All results in ug/l (ppb).

All undetected results listed at half-detection limit.

U - Undetected.

J - Estimated result.

NA - Not analyzed.

TABLE 2-3
CRANSTON SITE
PRODUCTION AREA
SHALLOW GROUNDWATER
INORGANIC DATA

TOTAL METALS

	SUB AREA	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13
	SAMPLE ID	MW-1S	MW-1S	MW-2S	MW-2S	MW-3S	MW-3S	MW-4S	MW-4S	MW-10S	MW-10S	MW-12S	MW-12S
	COLLECT DATE	3/6/96	5/1/96	3/5/96	4/30/96	3/6/96	5/2/96	3/6/96	5/1/96	3/5/96	4/30/96	3/5/96	5/2/96
		Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q
200.7	BERYLLIUM	0.55	0.34	NT	0.34	NT	0.28	NT	0.28	NT	0.32	NT	0.13 U
200.7	CADMIUM	9.7	4.7	1.4 U	1.4 U	5	6.5	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	7.9
200.7	CHROMIUM	17	4.9 U	4.9 U	4.9 U	4.9 U	4.9 U	4.9 U	4.9 U	910	880	4.9 U	11
200.7	COBALT	9.1	3.6 U	NT	3.6 U	NT	7.9	NT	8.1	NT	3.6 U	NT	7.5
200.7	COPPER	14	2.05 U	150	140	7.7	4.5	8.8	4.1	7.3	6.9	4.1	2.05 U
200.7	NICKEL	32	17	28	27	24	8 U	52	26	76	44	19	32
200.7	SILVER	2.7 U	2.7 U	2.7 U	2.7 U	2.7 U	2.7 U	2.7 U	2.7 U	2.7 U	2.7 U	2.7 U	2.7 U
200.7	ZINC	53	11	1500	1400	12	13	67	140	13	8.6	6.1	21
200.7	ARSENIC	11	11 U	27	11 U	58	57	11 U	28	11 U	11 U	11 U	35
200.7	LEAD	14 U	14 U	77	14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U	14 U
200.7	CYANIDE	34	5 U	53	11	5 U	6 U	12	5 U	5 U	5 U	18	5 U

DISSOLVED METALS

	SUB AREA	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13
	SAMPLE ID	MW-1S	MW-1S	MW-2S	MW-2S	MW-3S	MW-3S	MW-4S	MW-4S	MW-10S	MW-10S	MW-12S	MW-12S
	COLLECT DATE	3/6/96	5/1/96	3/5/96	4/30/96	3/6/96	5/2/96	3/6/96	5/1/96	3/5/96	4/30/96	3/5/96	5/2/96
		Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q
200.7	BERYLLIUM	NT	0.13 U	NT	0.13 U	NT	0.13 U	NT	0.13 U	NT	0.13 U	NT	0.13 U
200.7	CADMIUM	NT	1.4 U	NT	1.4 U	NT	1.4 U	NT	1.4 U	NT	1.4 U	NT	5.7
200.7	CHROMIUM	NT	4.9 U	NT	4.9 U	NT	4.9 U	NT	4.9 U	NT	4.9 U	NT	4.9 U
200.7	COBALT	NT	3.6 U	NT	3.6 U	NT	3.6 U	NT	8.1	NT	3.6 U	NT	3.6 U
200.7	COPPER	NT	2.05 U	NT	2.05 U	NT	2.05 U	NT	2.05 U	NT	2.05 U	NT	2.05 U
200.7	NICKEL	NT	8 U	NT	8 U	NT	8 U	NT	22	NT	32	NT	19
200.7	SILVER	NT	0.085 U	NT	0.085 U	NT	0.085 U	NT	0.085 U	NT	0.085 U	NT	0.085 U
200.7	ZINC	NT	11	NT	120	NT	2.1 U	NT	110	NT	2.1 U	NT	13
200.7	ARSENIC	NT	11 U	NT	11 U	NT	11 U	NT	11 U	NT	11 U	NT	11 U
200.7	LEAD	NT	0.425 U	NT	0.425 U	NT	0.425 U	NT	0.425 U	NT	0.425 U	NT	0.425 U

All results in ug/l (ppb).
All undetected results listed at
half detection limit.
[T] - unifiltered sample (total).
[D] - filtered sample (dissolved).
U - Undetected.
J - Estimated value.
R - Rejected value.
NA - Not analyzed.

TABLE 2-3
CRANSTON SITE
PRODUCTION AREA
SHALLOW GROUNDWATER
INORGANIC DATA

TOTAL METALS

	SUB AREA	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13
	SAMPLE ID	MW-13S	MW-13S	MW-13S	MW-20S	MW-20S	MW-21S	MW-21S	MW-22S	MW-22S	MW-110(P-37S)	MW-110(P-37S)	MW-120(P-35S)
	COLLECT DATE	3/6/96	5/1/96	5/2/96	3/5/96	4/30/96	3/6/96	5/1/96	3/5/96	4/30/96	3/6/96	5/2/96	3/5/96
		Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q
200.7	BERYLLIUM	NT	0.29	0.3	NT	0.51	NT	0.28	NT	0.93	1.8	0.79	0.48
200.7	CADMIUM	1200	1.4 U	1.4 U	1.4 U	1.4 U	4.6	1.4 U	1.4 U	1.4 U	9.7	3.2	1.4 U
200.7	CHROMIUM	480	4.9 U	4.9 U	700	470	21	4.9 U	50	350	120	41	21
200.7	COBALT	NT	3.6 U	9.5	NT	3.6 U	NT	9	NT	13	13	8.6	8.7
200.7	COPPER	840	6.5	5.3	15	11	24	9.9	12	21	100	33	12
200.7	NICKEL	590	8 U	8 U	41	34	41	8 U	27	39	46	8 U	21
200.7	SILVER	37	2.7 U	2.7 U	2.7 U	2.7 U	2.7 U	2.7 U	2.7 U	2.7 U	2.7 U	2.7 U	2.7 U
200.7	ZINC	4800	27	5.8	60	24	88	39	18	81	670	220	95
200.7	ARSENIC	3900	59	40	11 U	11 U	56	36	11 U	23	11 U	22	11
200.7	LEAD	980	14 U	14 U	14 U	14 U	28	14 U	14 U	14 U	170	52	53
200.7	CYANIDE	590	270	5 U	5 U	5 U	5 U	5 U	14	5 U	93	22	420

DISSOLVED METALS

	SUB AREA	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13
	SAMPLE ID	MW-13S	MW-13S	MW-13S	MW-20S	MW-20S	MW-21S	MW-21S	MW-22S	MW-22S	MW-110(P-37S)	MW-110(P-37S)	MW-120(P-35S)
	COLLECT DATE	3/6/96	5/1/96	5/2/96	3/5/96	4/30/96	3/6/96	5/1/96	3/5/96	4/30/96	3/6/96	5/2/96	3/5/96
		Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q
200.7	BERYLLIUM	NT	0.13 U	0.13 U	NT	0.13 U	NT	0.13 U	NT	0.13 U	NT	0.13 U	NT
200.7	CADMIUM	NT	1.4 U	1.4 U	NT	1.4 U	NT	1.4 U	NT	1.4 U	NT	1.4 U	NT
200.7	CHROMIUM	NT	4.9 U	4.9 U	NT	4.9 U	NT	4.9 U	NT	14	NT	4.9 U	NT
200.7	COBALT	NT	3.6 U	7.9	NT	3.6 U	NT	3.6 U	NT	3.6 U	NT	3.6 U	NT
200.7	COPPER	NT	2.05 U	2.05 U	NT	2.05 U	NT	2.05 U	NT	5.6	NT	2.05 U	NT
200.7	NICKEL	NT	8 U	8 U	NT	18	NT	8 U	NT	8 U	NT	8 U	NT
200.7	SILVER	NT	0.085 U	0.085 U	NT	0.085 U	NT	0.085 U	NT	0.085 U	NT	0.085 U	NT
200.7	ZINC	NT	5.8	2.1 U	NT	7	NT	13	NT	6.7	NT	7	NT
200.7	ARSENIC	NT	11 U	27	NT	11 U	NT	11 U	NT	11 U	NT	11 U	NT
200.7	LEAD	NT	1.4	1.4	NT	0.425 U	NT	0.425 U	NT	0.425 U	NT	0.9	NT

All results in ug/l (ppb).
All undetected results listed at half detection limit.
[T] - unifiltered sample (total).
[D] - filtered sample (dissolved).
U - Undetected.
J - Estimated value.
R - Rejected value.
NA - Not analyzed.

TABLE 2-3
CRANSTON SITE
PRODUCTION AREA
SHALLOW GROUNDWATER
INORGANIC DATA

TOTAL METALS

	SUB AREA	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13
	SAMPLE ID	MW-120(P-35S)	P-36S	P-36S	P-38S	P-38S	SW-110	SW-110	SW-120	SW-120	SW-130	SW-130
	COLLECT DATE	4/30/96	3/6/96	5/1/96	3/6/96	5/1/96	3/6/96	5/2/96	3/5/96	4/30/96	3/6/96	5/1/96
		Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q
200.7	BERYLLIUM	0.3	NT	1.3	NT	0.5	0.38	0.83	9.6	16	0.54	0.91
200.7	CADMIUM	1.4 U	7.1	4.4	8.3	4	6.7	3	36	68	5.1	4.4
200.7	CHROMIUM	4.9 U	270	170	98	13	20	4.9 U	140	300	25	24
200.7	COBALT	3.6 U	NT	7.8	NT	3.6 U	13	16	120	220	9.6	15
200.7	COPPER	11	130	82	130	24	18	24	150	230	32	67
200.7	NICKEL	8 U	28	8 U	41	19	34	24	200	360	47	38
200.7	SILVER	2.7 U	2.7 U	2.7 U	2.7 U	2.7 U	2.7 U	2.7 U	2.7 U	8.5	2.7 U	2.7 U
200.7	ZINC	95	490	330	200	38	54	41	550	960	100	330
200.7	ARSENIC	11 U	11 U	11 U	61	43	23	46	43	86	11 U	11 U
200.7	LEAD	52	240	120	230	14 U	14 U	14 U	85	120	14 U	14 U
200.7	CYANIDE	240	360	100	20	11	32	40	5 U	5 U	5 U	5 U

DISSOLVED METALS

	SUB AREA	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13	AOC13
	SAMPLE ID	MW-120(P-35S)	P-36S	P-36S	P-38S	P-38S	SW-110	SW-110	SW-120	SW-120	SW-130	SW-130
	COLLECT DATE	4/30/96	3/6/96	5/1/96	3/6/96	5/1/96	3/6/96	5/2/96	3/5/96	4/30/96	3/6/96	5/1/96
		Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q
200.7	BERYLLIUM	0.13 U	NT	0.13 U	NT	0.13 U	NT	0.13 U	NT	0.13 U	NT	0.13 U
200.7	CADMIUM	1.4 U	NT	1.4 U	NT	5.5	NT	3.7	NT	1.4 U	NT	3.1
200.7	CHROMIUM	4.9 U	NT	10	NT	11	NT	4.9 U	NT	4.9 U	NT	4.9 U
200.7	COBALT	7.8	NT	10	NT	3.6 U	NT	7.6	NT	3.6 U	NT	7.3
200.7	COPPER	2.05 U	NT	2.05 U	NT	2.05 U	NT	2.05 U	NT	2.05 U	NT	2.05 U
200.7	NICKEL	8 U	NT	8 U	NT	8 U	NT	8 U	NT	8 U	NT	8 U
200.7	SILVER	0.085 U	NT	0.085 U	NT	0.085 U	NT	0.085 U	NT	0.085 U	NT	0.35
200.7	ZINC	2.1 U	NT	6.1	NT	6	NT	6.9	NT	2.1 U	NT	11
200.7	ARSENIC	11 U	NT	11 U	NT	11 U	NT	11 U	NT	34	NT	11 U
200.7	LEAD	0.425 U	NT	0.85	NT	0.95	NT	0.425 U	NT	0.425 U	NT	0.425 U

All results in ug/l (ppb).
All undetected results listed at half detection limit.
[T] - unifiltered sample (total).
[D] - filtered sample (dissolved).
U - Undetected.
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Woodward-Clyde CONTAMINANT MASS CAPTURE
Engineering & sciences applied to the earth & its environment

June 20, 1996

Dr. Barry Berdahl
Ciba Corporation
Route 37 West
Toms River, NJ 08754

Subject: **Estimate of Contaminant Mass Intercepted by Recovery Wells PW-110 and PW-120 Based on Groundwater Sampling Performed March 5th and 6th, 1996.**

Dear Dr. Berdahl:

An estimate of the contaminant mass being intercepted by the concurrent pumping of recovery wells PW-110 and PW-120 has been calculated based upon groundwater quality data (comprehensive VOCs, and selected SVOCs and PCBs) collected in the Production Area from selected monitoring wells on March 5 and 6, 1996. This data was used to refine the earlier estimates of contaminant mass interception which were provided in the letter dated March 1, 1996. These updated estimates are based upon:

- pumping rates of 63.0 gpm (8.42 ft^3/min) for recovery well PW-110 and 3.2 gpm (0.43 ft^3/min) for recovery well PW-120;
- hydraulic transmissivity of the soils in the Production Area (Figure 1);
- the areal extent of capture zones associated with pumping of recovery wells PW-110 and PW-120 (Figures 2 through 7);
- selected contaminant (1,2-dichlorobenzene, chlorobenzene, ethylbenzene, ortho-chlorotoluene, toluene, and total xylenes) concentration distributions in the Production Area derived from the groundwater sampling of 17 wells on March 5th and 6th, 1996 (Figures 2 through 7); and
- a calculation of groundwater discharge rate from the Production Area to the Pawtuxet River (Table 1).

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Methodology

These estimates of contaminant mass interception are based upon the assumptions discussed below and upon equations for the calculation of groundwater discharge and extent of capture that are presented in Attachment A:

1. The six selected compounds are representative of contaminants present in the Production Area groundwater at the following concentrations (Table 2):

- the representative concentration of 1,2-dichlorobenzene is 37 ppb;
- the representative concentration of chlorobenzene is 438 ppb;
- the representative concentration of ethylbenzene is 34 ppb;
- the representative concentration of ortho-chlorotoluene is 380 ppb;
- the representative concentration of toluene is 440 ppb; and
- the representative concentration of total xylenes is 71 ppb.

2. The representative concentration for each compound of concern was derived by applying geostatistical techniques (USEPA, 1991) to the data from the March 5-6, 1996 (Figures 2 through 7). These geostatistical techniques included:

- a variographic analysis of the data for each compound;
- the development of a theoretical model to fit the variogram;
- contouring of the data utilizing the theoretical model; and
- calculation of the average representative concentration from the resultant matrix of values.

3. Contaminant mass distributions are present in the Production Area in the concentrations noted above and are distributed equally in the manner throughout the vertical dimension. Because a three-dimensional model would entail a very detailed analysis of Site

hydrogeological and chemical data, a two-dimensional model was considered to be more appropriate for this estimate.

4. The areal extent of the capture zone associated with each recovery well was based upon aquifer hydraulic characteristics derived from aquifer pumping tests, groundwater drawdown in the overburden aquifer with both recovery wells pumping, and hydrogeologic conditions observed at the Site from 1992 through 1995.

Results

Based upon the above assumptions, the estimate of groundwater contaminant mass loading to the Pawtuxet River from the Production Area **(without any pumping of PW-110 and PW-120)** is:

- 1,2-dichlorobenzene (given a representative concentration of 37 ppb) = 1.97×10^{-2} lbs/day;
- chlorobenzene (given a representative concentration of 438 ppb) = 2.33×10^{-1} lbs/day;
- ethylbenzene (given a representative concentration of 34 ppb) = 1.81×10^{-2} lbs/day;
- ortho-chlorotoluene (given a representative concentration of 380 ppb) = 2.02×10^{-1} lbs/day;
- toluene (given a representative concentration of 440 ppb) = 2.34×10^{-1} lbs/day; and
- total xylenes (given a representative concentration of 71 ppb) = 3.78×10^{-2} lbs/day.

The capture zones associated with both recovery wells extend approximately 366 linear feet along the 420 feet of Production Area frontage adjacent to the Pawtuxet River. Therefore,

the estimate of groundwater contaminant mass loading to the river **(during pumping of PW-110 and PW-120 at 63.0 and 3.2 gpm, respectively)** is:

- 1,2-dichlorobenzene (given a representative concentration of 37 ppb) = 8.08×10^{-4} lbs/day;
- chlorobenzene (given a representative concentration of 438 ppb) = 9.57×10^{-3} lbs/day;
- ethylbenzene (given a representative concentration of 34 ppb) = 7.43×10^{-4} lbs/day;
- ortho-chlorotoluene (given a representative concentration of 380 ppb) = 8.30×10^{-3} lbs/day;
- toluene (given a representative concentration of 440 ppb) = 9.61×10^{-3} lbs/day; and
- total xylenes (given a representative concentration of 71 ppb) = 1.55×10^{-3} lbs/day.

The difference between the two sets of estimates is the contaminant mass loading intercepted by the recovery wells. Dividing this difference by the contaminant mass loading prior to pumping and multiplying by 100 yields the percentage of contaminant mass intercepted by the two recovery wells. **The contaminant mass intercepted by the recovery wells is calculated to be approximately 96% for each compound of concern.**

These are reasonable estimations of interception percentages and should be considered best case scenarios. Actual interception of contaminant mass may be less. The limitations or uncertainties associated with these estimations are discussed below.

Limitations

Several factors could cause a reduction in the amount of contaminant mass actually collected in the recovery wells in comparison to the above estimates. These factors which are not part of the assumptions for the estimates include:

- the presence of subsurface structures (e.g., building foundations, piping conduits, etc.) which can channel and/or block groundwater movement and entrained compounds;
- the presence of non-aqueous phase compounds; and
- sorption processes in soils.

For estimation purposes, each compound is assumed to be at a single representative concentration over the entire Production Area. Concentration ranges for each compound are as follows:

- 1,2-dichlorobenzene = 1.1 to 340 ppb;
- chlorobenzene = 1.5 to 3,200 ppb;
- ethylbenzene = 1.4 to 110 ppb;
- ortho-chlorotoluene = 1 to 1700 ppb;
- toluene = 1.2 to 2,100 ppb; and
- total xylenes = 1.7 to 300 ppb.

The lower number represents a concentration for each compound based upon the following criteria:

1. For Non-detected values, 1/2 of the MDL ("B" qualifier) was used.
2. Where samples were analyzed twice and the results were both ND ("B" qualifier), 1/2 the average of the two MDLs was used.

We trust that this information is adequate for your needs. If you have any questions, please do not hesitate to call us at 201-785-0700.

Sincerely,

Rezie Z. Jan
Hydrogeologist

Gordon R. Jamieson
Chief Hydrogeologist

GRJ:rzj

Enclosures

c: Barry Cohen
Mark Houlday

Attachment A

1. The areal extent of a capture zone associated with pumping is made using the following relationship, as discussed in Javandel and Tsang (1986):

$$Y = \frac{Q}{2\pi TI}$$

where:

Y = distance to the downgradient stagnation point (ft).
Q = pumping rate (ft^3/min).
T = transmissivity (ft^2/min).
I = natural hydraulic gradient (ft/ft).

and,

$$B = 2\pi Y$$

where:

B = lateral extent of capture zone at some distance upgradient of the pumping well (ft).

The results from the Site are presented in Table 3.

2. The volume of groundwater discharged to the frontage along Pawtuxet River from the Production Area is calculated using:

$$Q' = TIL$$

where,

Q' = groundwater discharge volume (ft^3/min).
T = transmissivity (ft^2/min).
I = natural hydraulic gradient (ft/ft).
L = length of river frontage (ft).

References

Javandel, I., and Tsang, C. 1986. Capture zone type curves: a tool for aquifer cleanup. Groundwater, v. 24, no. 5, pp. 616-625.

United States Environmental Protection Agency. 1991. GEO-EAS 1.2.1 User's Guide: EPA 600/8-91/008, April 1991.

Table 1
Groundwater Discharge to Pawtuxet River
Ciba-Geigy Facility
Cranston, Rhode Island

	Estimate of Groundwater Flow - Natural Conditions (No Pumping)						
	T (ft^2/min)	I (ft/ft)	L (ft)	Q (ft^3/min)	Q (gal/min)	Q (ft^3/day)	Q (gal/day)
1	1.5	0.015	187	4.2	31.5	6,062.4	45,350
2	0.8	0.015	83	1.0	7.5	1,440.0	10,772
3	0.3	0.015	96	0.4	3.2	619.2	4,632
4	0.3	0.015	54	0.2	1.8	349.9	2,618
	TOTALS		**420.0**	**5.9**	**44.0**	**8,471.5**	**63,371**
	Estimate of Intercepted Groundwater - Recovery Wells PW-110/PW-120 Pumping						
	T (ft^2/min)	I (ft/ft)	L (ft)	Q (ft^3/min)	Q (gal/min)	Q (ft^3/day)	Q (gal/day)
5	1.5	0.015	187	4.2	31.5	6,062.4	45,350
6	0.8	0.015	83	1.0	7.5	1,440.0	10,772
7	0.3	0.015	96	0.4	3.2	619.2	4,632
8							
	TOTALS		**366.0**	**5.6**	**42.2**	**8,121.6**	**60,754**

Notes:

Rows 1, 2, 5, and 6 represent transmissivity values contained within the capture zone of PW-110.
Rows 3 and 7 represent transmissivity values contained within the capture zone of PW-120.
Rows 4 and 8 represent transmissivity values for the area outside of the capture zones.
Row 8 is blank since this area is not contained within a capture zone.
Areas representative of the above transmissivities are presented in Figure 1.

Table 2
Compound Concentrations (ppb) in Groundwater (Groundwater Sampling March 5 and 6, 1996)
Ciba-Geigy Facility
Cranston, Rhode Island

Sampling Location			Selected Compound of Concern					
Well No.	Easting	Northing	1,2-Dichlorobenzene	Chlorobenzene	Ethylbenzene	ortho-Chlorotoluene	Toluene	Total Xylenes
MW-001S	523990.88	248849.44	1.1	2000	28	5	16	18
MW-002S	523904.81	248697.91	340	3200	27	25	200	42.5
MW-003S	524119.09	248937.06	2.15	5.7	1.4	6.5	11	1.7
MW-004S	523860.29	249005.42	89	210	110	1700	2100	300
MW-010S	523867.42	249130.69	2.15	1.5	1.4	1	1.4	1.7
MW-012S	523928.71	249087.9	2.15	2.4	77	1	1.4	75
MW-013S	524005.73	248966.55	2.15	7.6	5.6	1	1.4	1.7
MW-020S	523746.39	249135.33	2.15	1.5	1.4	1	1.4	1.7
MW-021S	523754.94	248833.96	21.5	15	14	480	12	17
MW-022S	523774.24	248691.83	2.15	200	1.4	12	1.4	1.7
MW-029S/SW-110	524044.9	248856.36	46	1600	19	55	460	14
MW-030S/SW-130	524018.83	248829.79	2.15	1.5	1.4	6.5	1.4	14
MW-031S/SW-120	523948.45	248733.93	1.42	63	1.4	1	1.4	42.5
P-035S/MW-120	523937.41	248746.34	13	460	1.4	10	1.2	17
P-036S	523974.56	248800.73	11	440	7	5	7	8.5
P-037S/MW-110	524032.3	248869.38	1.2	900	7	75	7	8.5
P-038S	524085.78	248913.77	2.15	2.4	1.4	1	1.3	1.7
data minimum			1.1	1.5	1.4	1	1.2	1.7
data maximum			340	3200	110	1700	2100	300
geostatistical mean			**36.4**	**437.7**	**33.5**	**379.9**	**439.3**	**70.9**

NOTE:

1 For Non-detected values, 1/2 of the MDL ("B" qualifier) was used.

2 Where samples were analyzed twice and the results were both ND ("B" qualifier), 1/2 the average of the two MDLs was used.

3 Geostatistical mean based on extrapolated (contoured) concentrations using techniques described in 'Geo-Eas 1.2.1 User's Guide, EPA 600/8-91-008, April 1991'.

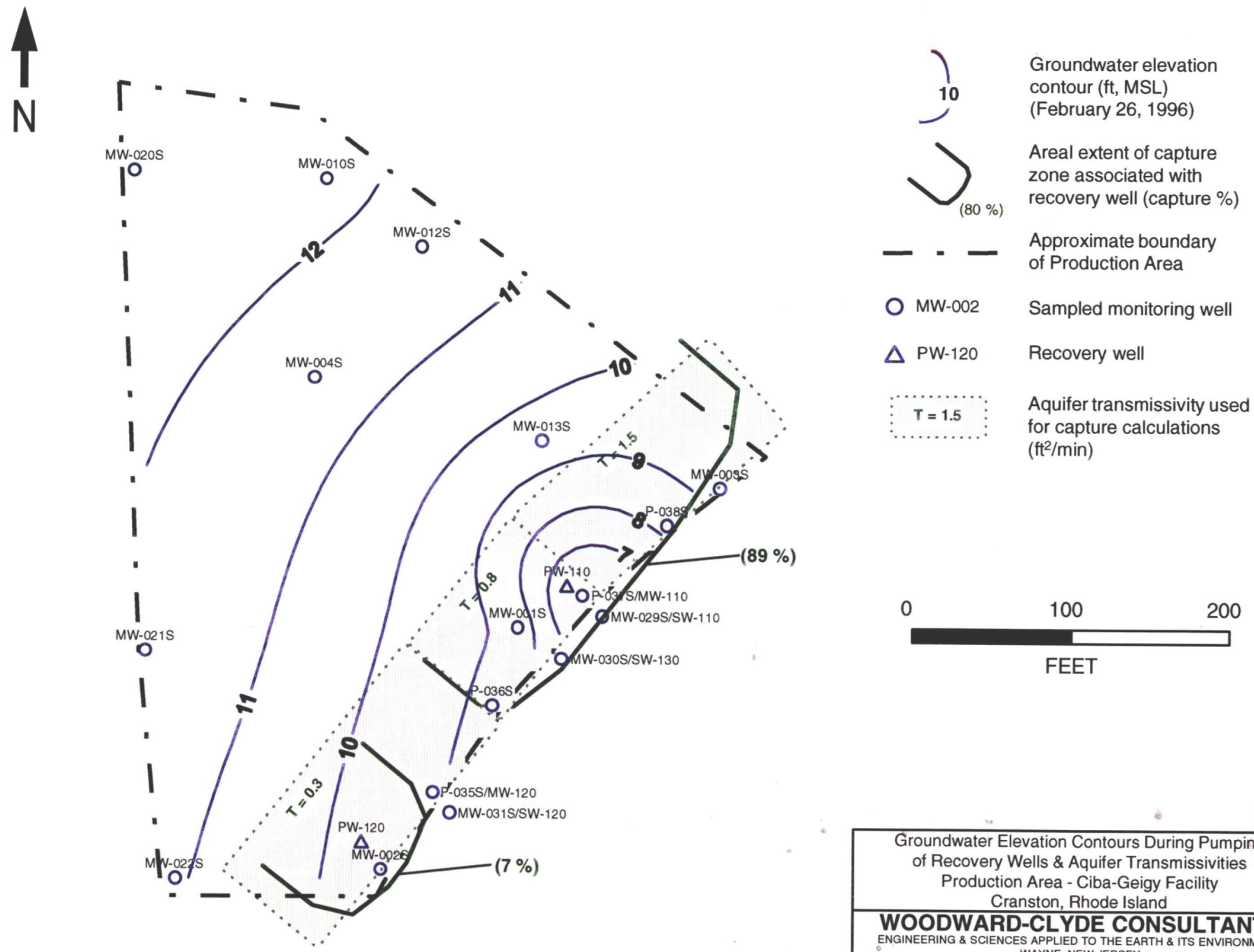
Table 3
Areal Extent of Capture Zones Associated with Recovery Wells in Production Area
Ciba-Geigy Facility
Cranston, Rhode Island

Stagnation Point: $Y = Q/ 2\pi TI$
Lateral Extent of Capture Zone: $B = 2\pi Y$
Q = pumping rate; T = transmissivity; I = natural hydraulic gradient

	I (ft/ft)	T (ft^2/min)	Q (ft^3/min)	Y	B
	PW-110/RC-3				
1	0.015	1.5	8.42	59.6	374.2
2	0.015	0.8	2	26.5	166.7
	PW-120/RC-5				
3	0.015	0.3	0.43	15.2	95.6

Notes:

Rows 1 and 2 represent transmissivity values contained within the capture zone of PW-110.
Row 3 represents transmissivity values contained within the capture zone of PW-120.



Groundwater Elevation Contours During Pumping of Recovery Wells & Aquifer Transmissivities
Production Area - Ciba-Geigy Facility
Cranston, Rhode Island

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WAYNE, NEW JERSEY

DR. BY: RZJ	SCALE: AS SHOWN	PROJ. NO.: 87X4660D
CK'D. BY: GRJ	DATE: JUN 19, 1996	FIG. NO.: 1

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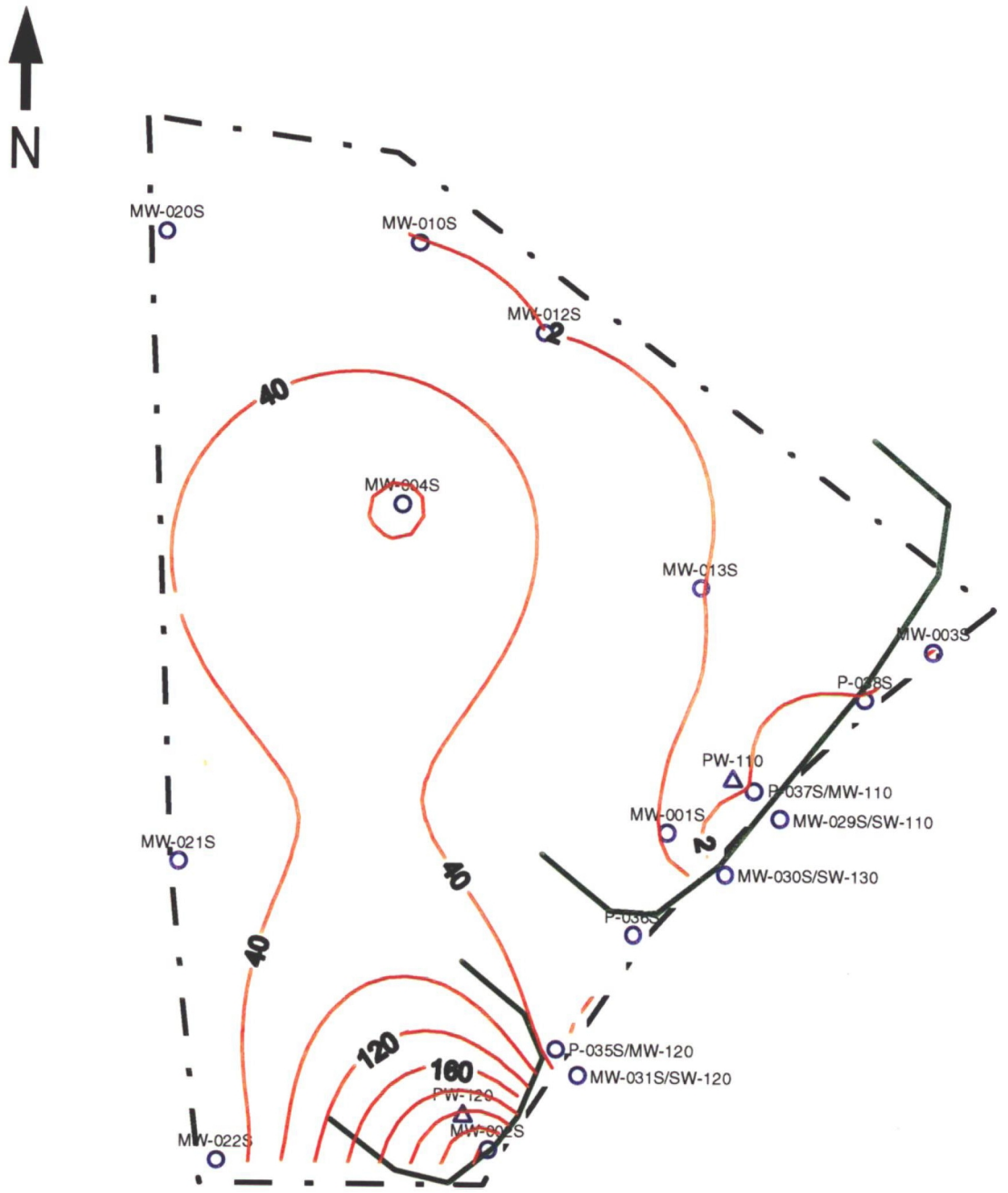

Compound concentration isopleth (ppb)(Groundwater Sampling March 5-6, 1996)

Areal extent of capture zone associated with recovery well

Approximate boundary of Production Area

MW-002 Sampled monitoring well

PW-120 Recovery well

0 100 200

FEET

Notes:

1. For Non-detected values, 1/2 of the MDL ("B" qualifier) was used.
2. Where samples were analyzed twice and the results were both ND ("B" qualifier), 1/2 the average of the two MDLs was used.
3. Data from the 17 monitoring wells was kriged to generate the contours.

1,2-Dichlorobenzene Concentration Isopleths
& PW-110/PW-120 Capture Zones
Production Area - Ciba-Geigy Facility
Cranston, Rhode Island

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CK'D. BY: GRJ	DATE: JUN 19, 1996	FIG. NO.: 2

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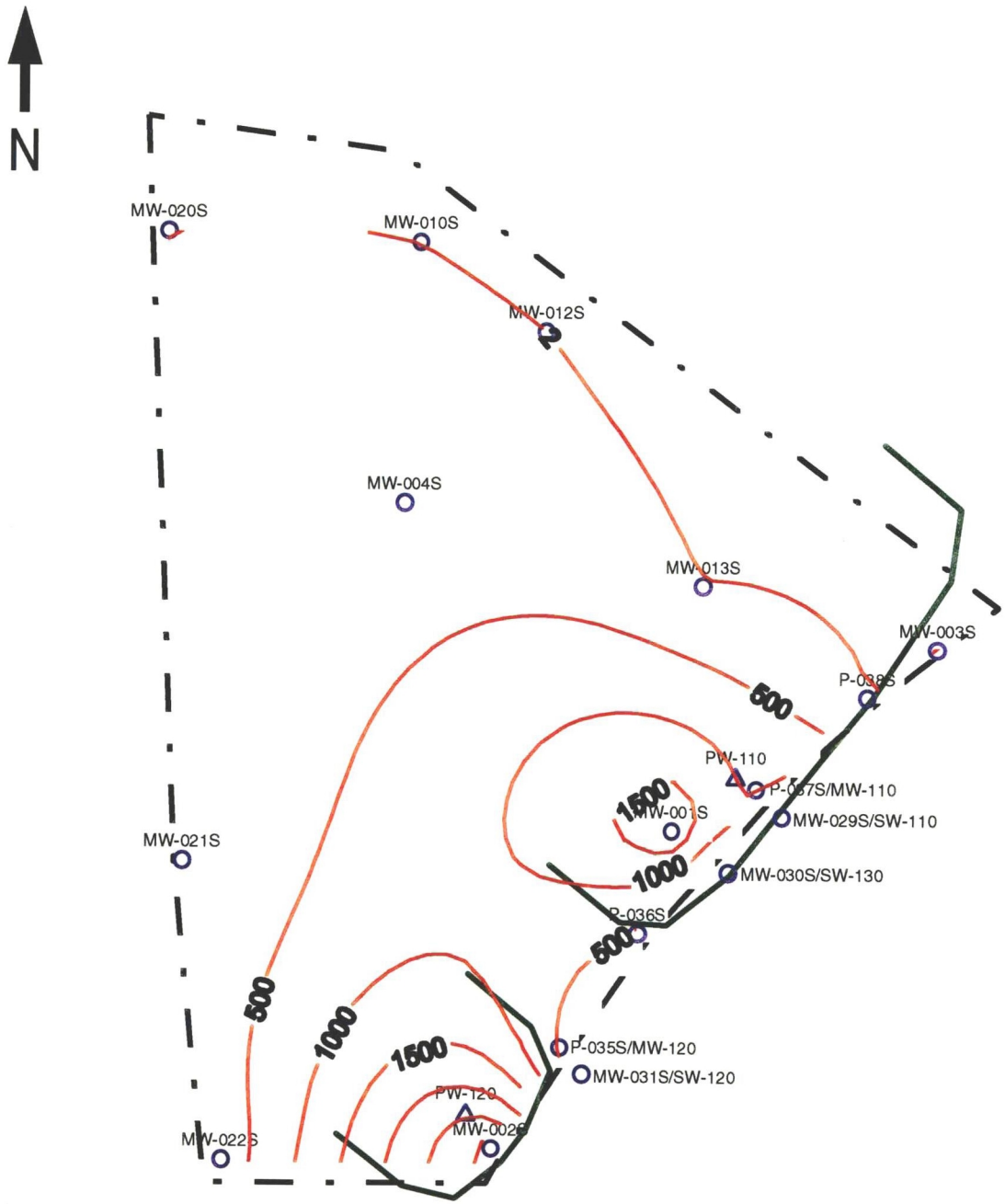

40 — Compound concentration isopleth (ppb)(Groundwater Sampling March 5-6, 1996)

Areal extent of capture zone associated with recovery well

Approximate boundary of Production Area

MW-002 — Sampled monitoring well

PW-120 — Recovery well

0 100 200

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Notes:

1. For Non-detected values, 1/2 of the MDL ("B" qualifier) was used.
2. Where samples were analyzed twice and the results were both ND ("B" qualifier), 1/2 the average of the two MDLs was used.
3. Data from the 17 monitoring wells was kriged to generate the contours.

Chlorobenzene Concentration Isopleths
& PW-110/PW-120 Capture Zones
Production Area - Ciba-Geigy Facility
Cranston, Rhode Island

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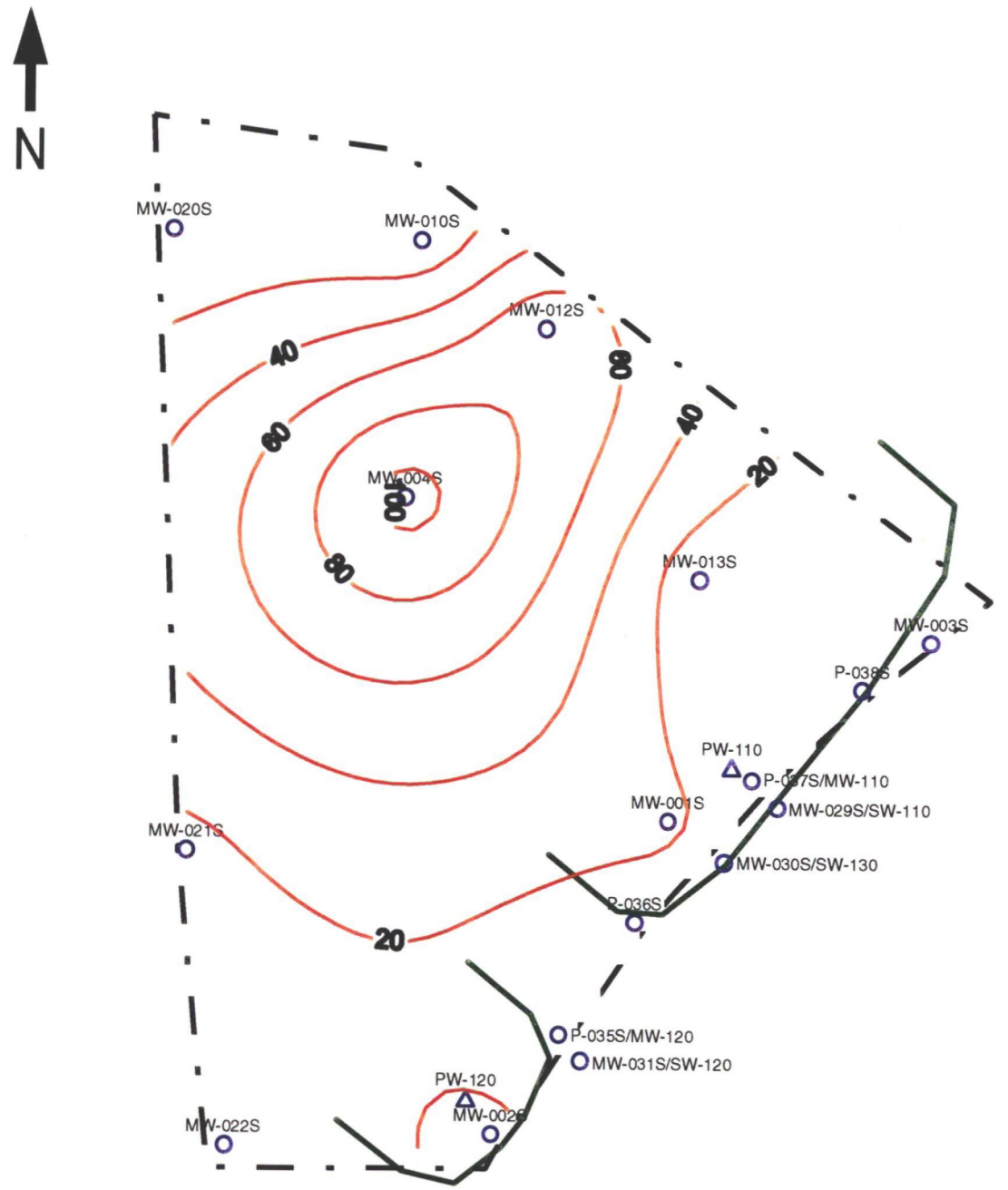

Compound concentration isopleth (ppb)(Groundwater Sampling March 5-6, 1996)

Areal extent of capture zone associated with recovery well

Approximate boundary of Production Area

MW-002 Sampled monitoring well

PW-120 Recovery well

0 100 200

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Notes:

1. For Non-detected values, 1/2 of the MDL ("B" qualifier) was used.
2. Where samples were analyzed twice and the results were both ND ("B" qualifier), 1/2 the average of the two MDLs was used.
3. Data from the 17 monitoring wells was kriged to generate the contours.

Ethylbenzene Concentration Isopleths
& PW-110/PW-120 Capture Zones
Production Area - Ciba-Geigy Facility
Cranston, Rhode Island

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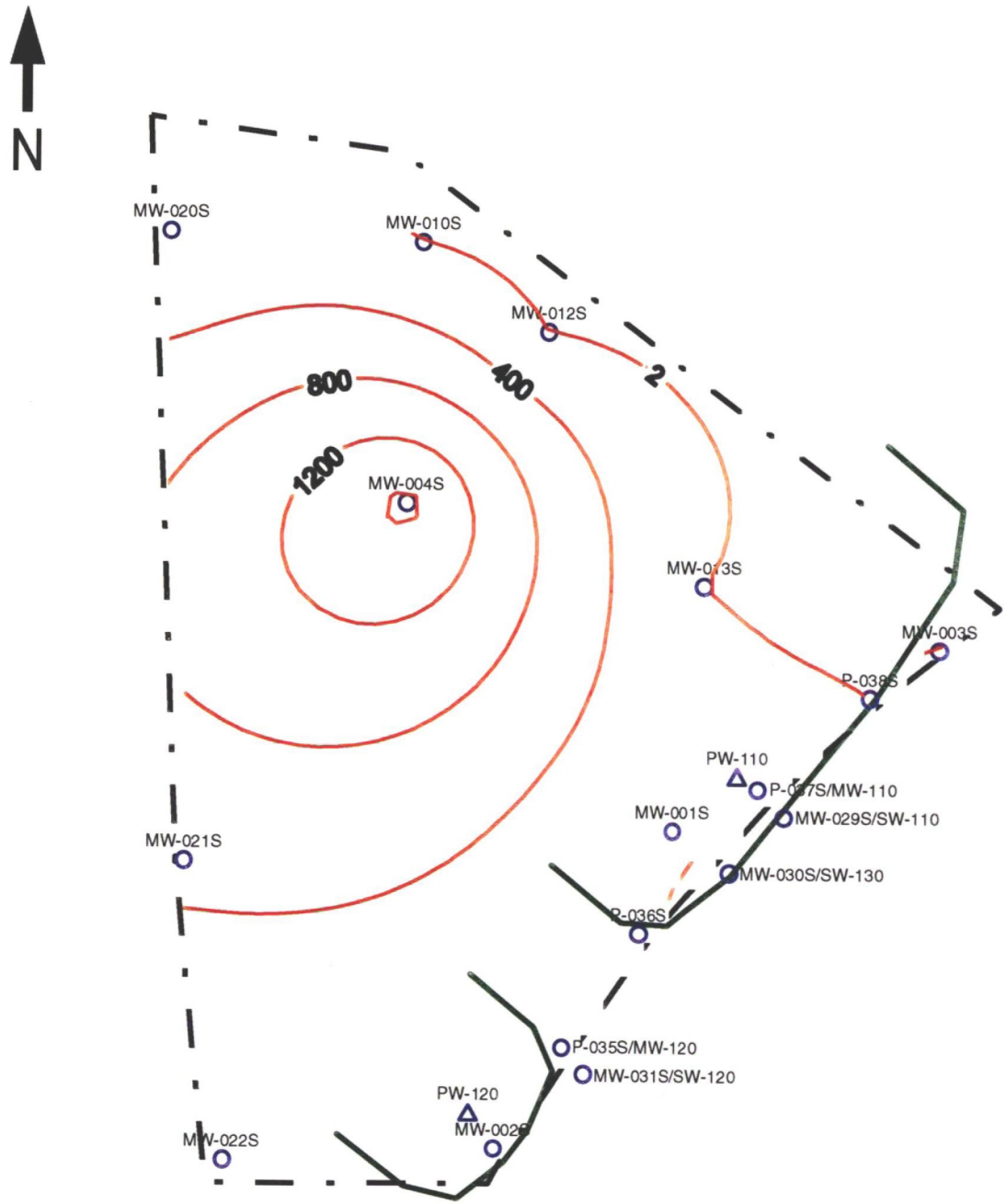

40 — Compound concentration isopleth (ppb)(Groundwater Sampling March 5-6, 1996)

Areal extent of capture zone associated with recovery well

Approximate boundary of Production Area

MW-002 — Sampled monitoring well

PW-120 — Recovery well

0 100 200

FEET

Notes:

1. For Non-detected values, 1/2 of the MDL ("B" qualifier) was used.
2. Where samples were analyzed twice and the results were both ND ("B" qualifier), 1/2 the average of the two MDLs was used.
3. Data from the 17 monitoring wells was kriged to generate the contours.

ortho-Chlorotoluene Concentration Isopleths
& PW-110/PW-120 Capture Zones
Production Area - Ciba-Geigy Facility
Cranston, Rhode Island

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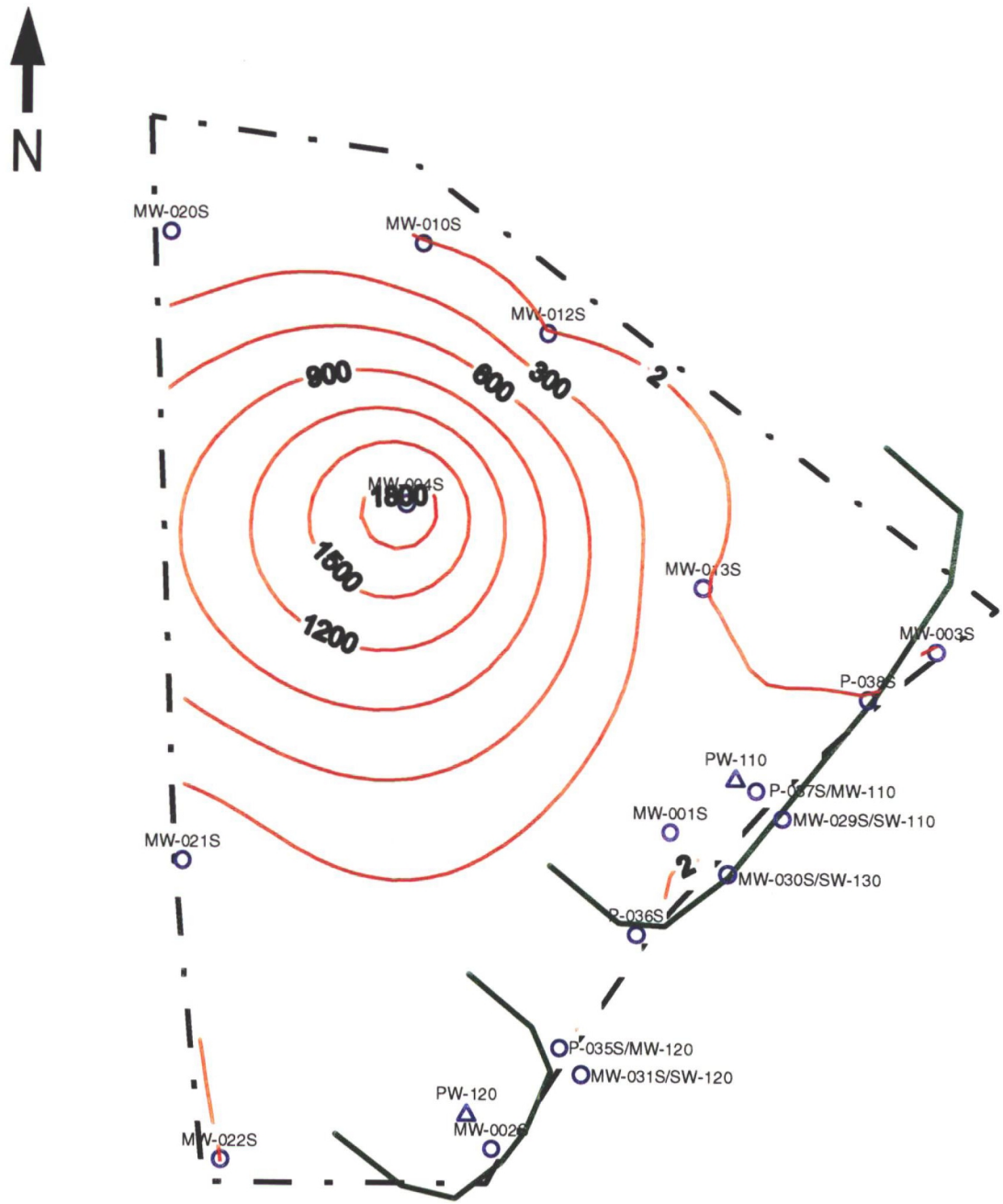

40 — Compound concentration isopleth (ppb)(Groundwater Sampling March 5-6, 1996)

Areal extent of capture zone associated with recovery well

Approximate boundary of Production Area

MW-002 — Sampled monitoring well

PW-120 — Recovery well

0 100 200

FEET

Notes:

1. For Non-detected values, 1/2 of the MDL ("B" qualifier) was used.
2. Where samples were analyzed twice and the results were both ND ("B" qualifier), 1/2 the average of the two MDLs was used.
3. Data from the 17 monitoring wells was kriged to generate the contours.

Toluene Concentration Isopleths
& PW-110/PW-120 Capture Zones
Production Area - Ciba-Geigy Facility
Cranston, Rhode Island

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DR. BY: RZJ	SCALE: AS SHOWN	PROJ. NO.: 87X4660D
CK'D. BY: GRJ	DATE: JUN 19, 1996	FIG. NO.: 6

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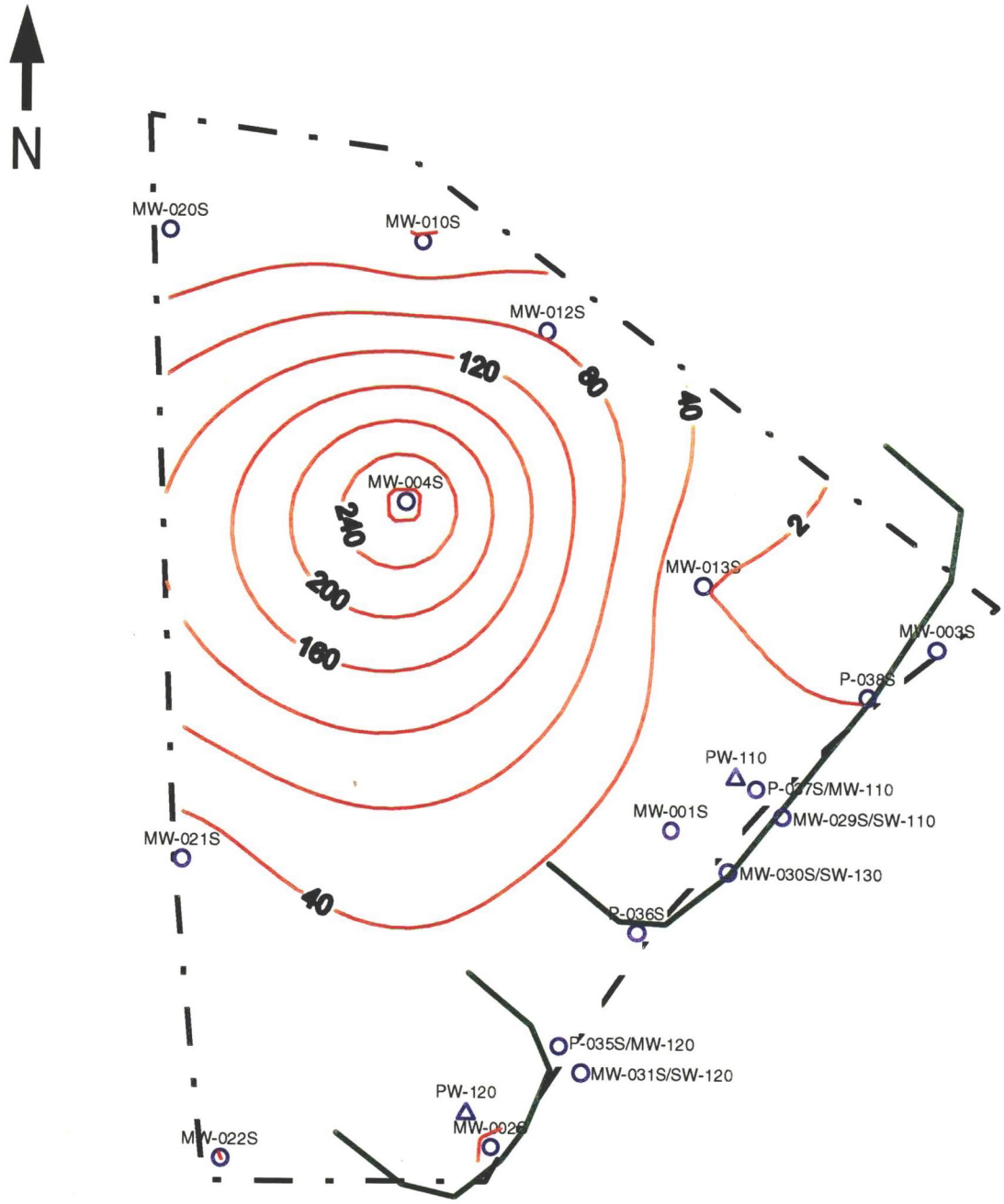

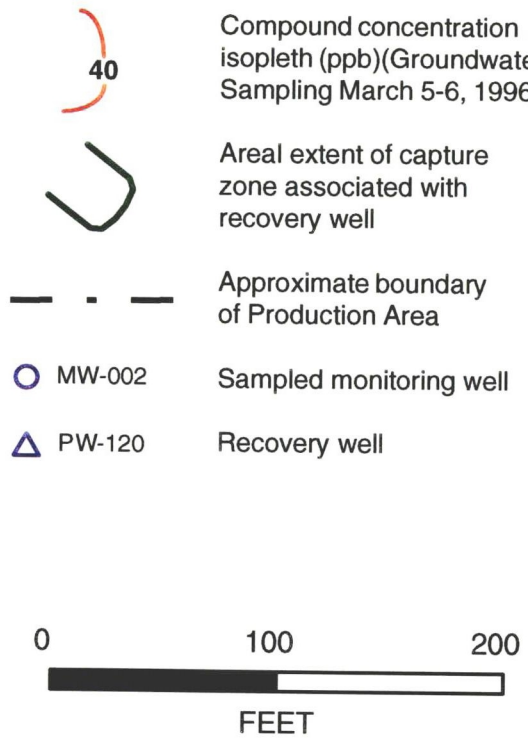

Notes:

1. For Non-detected values, 1/2 of the MDL ("B" qualifier) was used.
2. Where samples were analyzed twice and the results were both ND ("B" qualifier), 1/2 the average of the two MDLs was used.
3. Data from the 17 monitoring wells was kriged to generate the contours.

Total Xylenes Concentration Isopleths
& PW-110/PW-120 Capture Zones
Production Area - Ciba-Geigy Facility
Cranston, Rhode Island

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DR. BY: RZJ	SCALE: AS SHOWN	PROJ. NO.: 87X4660D
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Woodward-Clyde
Engineering & sciences applied to the earth & its environment

June 20, 1996

Mr. Barry Cohen
Ciba Corporation
Route 37 West
Toms River, NJ 08754

Subject: Location of Groundwater Capture System Performance Monitoring Wells

Dear Barry,

In our recent teleconference you requested that we review the locations and depths of the current monitoring wells used for performance standards at the Cranston, Rhode Island site and determine whether the wells are appropriately situated. The following information discusses the monitoring well locations, previous and current water levels and appropriateness of the well locations and depths.

1.0 Background

The performance monitoring wells consist of three pairs of monitoring wells at different locations along the bulkhead. Each pair consists of one monitoring well in the production area near the bulkhead and one monitoring well in the river. The monitoring well pairs are as follows:

Production Area	In-River
MW-110 (formerly P-37S)	SW-110 (formerly MW-29S)
MW-120 (formerly P-35S)	SW-120 (formerly MW-31S)
MW-130 (formerly P-1S)	SW-130 (formerly MW-30S)

In the stabilization investigation report dated January 1995, it was stated that the difference in water level elevations between the pairs would be used as a criteria to illustrate that hydraulic control of the production area groundwater had been achieved through the pump and treat system. In each pair the water level elevation in the In-River monitoring well has to be higher than the Production Area monitoring well. This illustrates that groundwater is no longer discharging to the river. The water level criteria varies along the site and is as follows:

Monitoring Well Pair	Water Level Differential
MW-110 and SW-110	1.7 feet
MW-130 and SW-130	1.0 feet
MW-120 and SW-120	0.5 feet

2.0 Pre-Stabilization Conditions

Figure 1 (attached) shows the locations of cross-sections at the site. Figures 2, 3 and 4 (attached) depict these three cross-sections. Cross-section A-A' is through the area of MW-110 and SW-110. Cross-section B-B' is through the area of MW-130 and SW-130. Cross-section C-C' is through the area of MW-120 and SW-120. The numbers beside each well screen represents the head (water level) measurement in each well on 10/31/94 which is prior to stabilization pumping activities. The head distribution in all three cross sections illustrates that groundwater is moving across the site and

discharging into the Pawtuxet River. Note that the head in the MW/SW pairs is greater in the MW well than the SW well in all three cross sections indicating that shallow groundwater is moving down and around the bulkhead and discharging into the river.

3.0 Post-Stabilization Conditions

Figures 5, 6 and 7 (attached) depict cross-sections A-A', B-B' and C-C' as discussed in section 2. The numbers beside each well screen represents the head measurement in each well on 3/28/96 which is several months after stabilization pumping has commenced at PW-110 and PW-120. The head distribution in cross section A-A' illustrates that groundwater is moving from the Pawtuxet River onto the site towards PW-110. The head distribution in cross section B-B' illustrates that groundwater is continuing to move from the site towards and into the Pawtuxet River. The current pumping wells PW-110 and PW-120 are too far away from this area to reverse the flow. However, when compared with pre-stabilization heads in Figure 3, the pumping has reduced the gradient from the site to the river ; thus reducing the volume of water discharging from the site to the river. The head distribution in cross section C-C' illustrates that the groundwater is continuing to move from the site towards and into the Pawtuxet River. The current pumping at PW-120 is not sufficient to reverse the flow.

The current stabilization system is capturing a large percentage of the water and contaminants that were formerly discharging to the Pawtuxet River. The amount of capture has been evaluated and presented to you in a letter with the subject title "Estimate of Contaminant Mass Intercepted by Recovery Wells PW-110/PW-120."

4.0 Locations of Performance Standard Wells

4.1 Monitoring Well Pair MW-110 and SW-110

Cross section A-A' (Figures 2 and 5) illustrate the location of MW-110 and SW-110. MW-110 is located in a clean fine sand and SW-110 is located in a silty medium fine sand. The materials at each well are similar and the wells are in the same hydrogeoloic unit. Both wells have responded to pumping at PW-110, and the water level differential has been reversed to over 2 feet which is more than the criteria of 1.7 feet. Therefore, the location of the monitoring well pair is appropriate.

4.2 Monitoring Well Pair MW-130 and SW-130

Cross section B-B' (Figures 3 and 6) illustrate the location of MW-130 and SW-130. MW-130 is located in fill material in the production area that tends to be a medium to fine sandy material. SW-130 is located in a silty fine to medium sand. In this area the fill and the silty fine to medium sand are separated by a 5 foot layer of silty sandy, clay to silty fine sand with clay layers. It is possible that this 5 foot layer separates the fill and silty fine to medium sand into two separate hydrogeologic units. A more appropriate depth for MW-130 would be 10 to 15 deeper with the screened interval in the silty fine to medium sand.

4.3 Monitoring Well Pair MW-120 and SW-120

Cross section C-C' (Figures 4 and 7) illustrate the location of MW-120 and SW-120. MW-120 and SW-120 are both located in a grey silt. A portion of the screened interval in MW-120 is also completed in the fill material. The materials at each well are similar and the wells are in the same hydrogeologic unit. Therefore, the location of the monitoring well pair is appropriate.

5.0 Conclusions

The well pairs MW-110/SW-110 and MW-120/SW-120 are in the same hydrogeologic units, and their locations and depth are appropriate. The well pair MW-130/SW-130 are not in the same hydrogeologic unit. It would be more appropriate if MW-130 was in the same location but 10 to 15 feet deeper with a screened interval in the silty fine to medium sand. We do not recommend installing a deeper monitoring well (MW-130) at this time because 1)differential measurements in water levels are no longer critical to the stabilization IRM, and 2)capture of contaminant mass flowing to the Pawtuxet River from the Production Area groundwater is greater than 90%, as outlined in the letter with the subject title "Estimate of Contaminant Mass Intercepted by Recovery Wells PW-110/PW-120".

If you have any questions, please do not hesitate to call Gordon Jamieson at (201) 812-6834 or Rezie Jan at (201) 785-8013 (ext. 331).

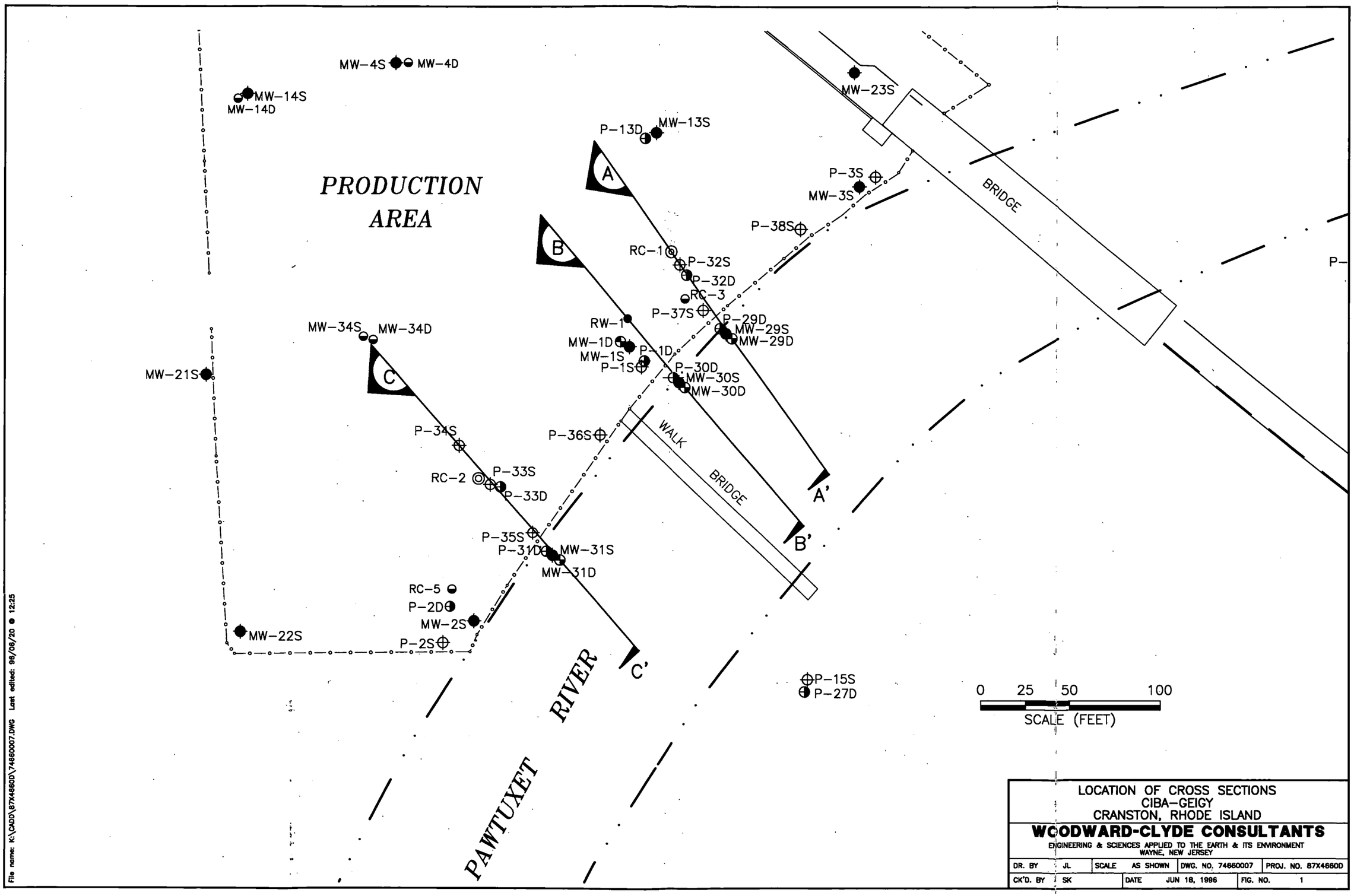
Sincerely,

Rezie Jan
Hydrogeologist

Gordon R. Jamieson
Chief Hydrogeologist

Attachments

c: Dr. Barry Berdahl, Ciba
Mark Houlday, WCC



LOCATION OF CROSS SECTIONS
CIBA-GEIGY
CRANSTON, RHODE ISLAND

WOODWARD-CLYDE CONSULTANTS

ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY

DR. BY	JL	SCALE	AS SHOWN	DWG. NO. 74660007	PROJ. NO. 87X4660D
CK'D. BY	SK		DATE JUN 18, 1996	FIG. NO. 1	

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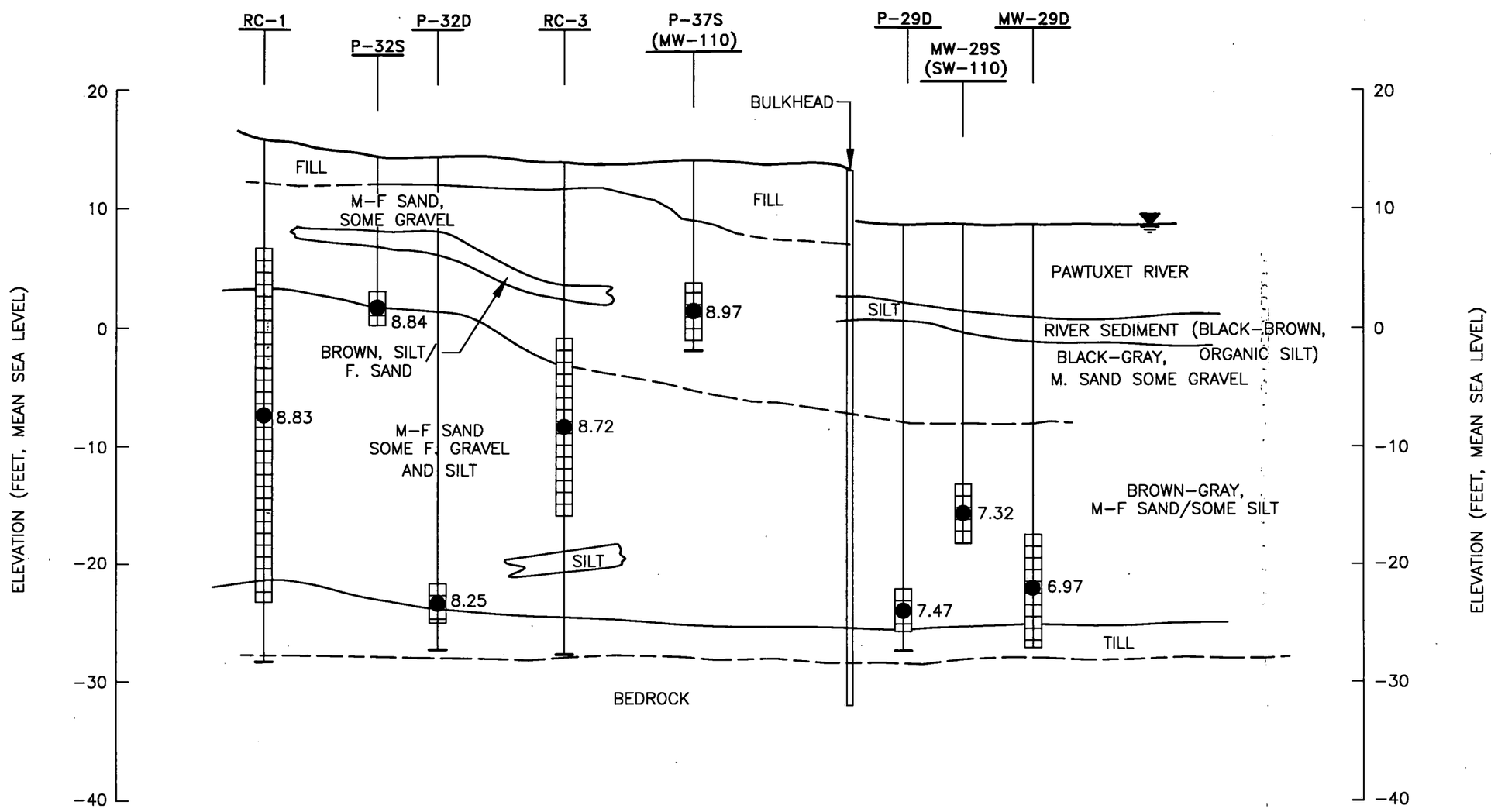

NOTES:

1. STRATA BOUNDARIES AND CONTINUITY BETWEEN BORING LOCATIONS ARE INFERRED AND ARE SHOWN ONLY TO AID IN VISUALIZING SUBSURFACE CONDITIONS. ACTUAL STRATA BOUNDARIES MAY DIFFER FROM CONDITION SHOWN.
2. BORING LOCATION MAY BE PROJECTED TO PROFILE.

0 5 10 20
HORIZONTAL SCALE (FEET)
VERTICAL SCALE (FEET)

CROSS-SECTION A-A'
GROUNDWATER ELEVATIONS 10/31/94

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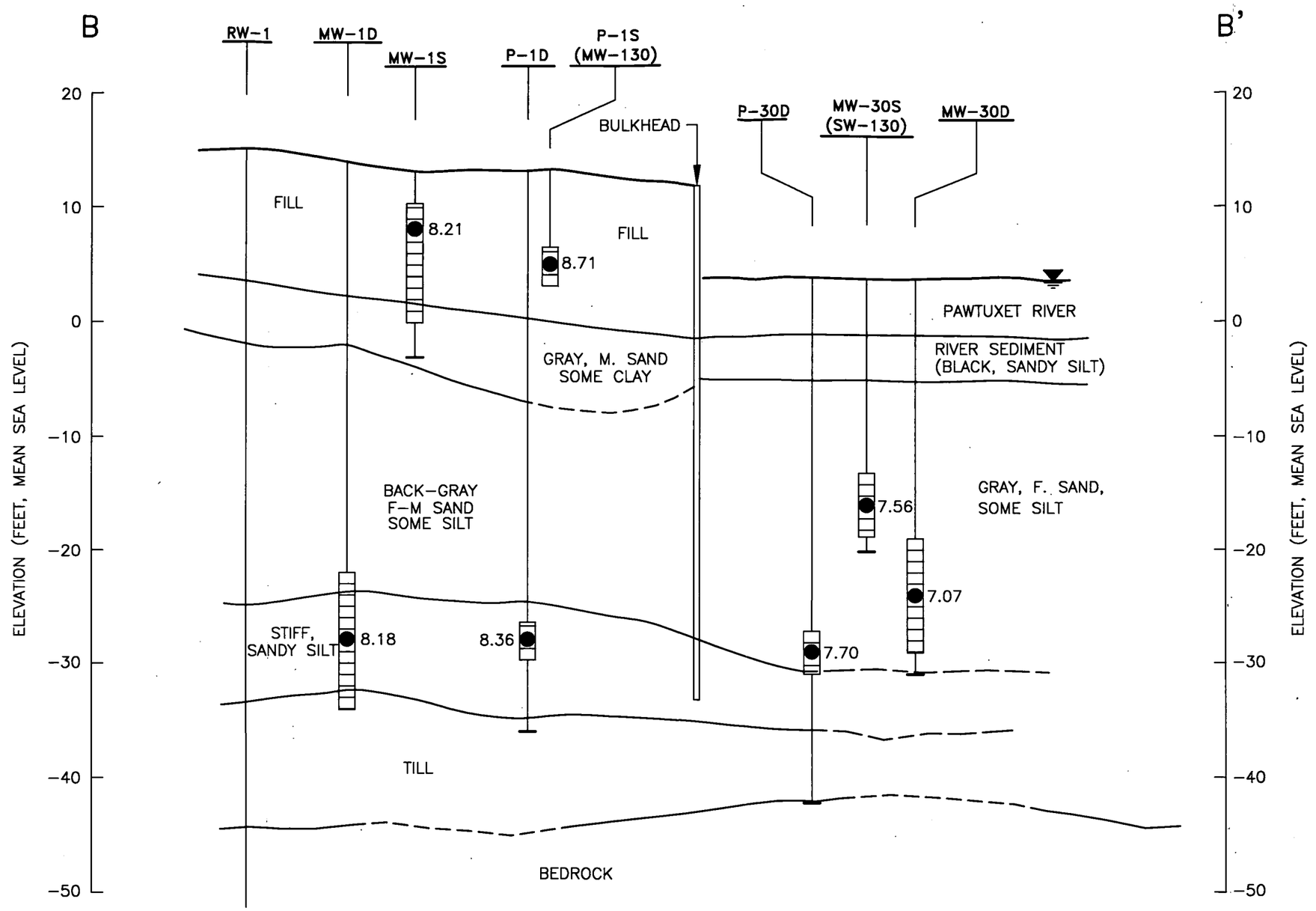
WAYNE, NEW JERSEY

DR. BY	FWD	SCALE	AS SHOWN	DWG. NO. 74860001	PROJ. NO. 87X4860D
CK'D. BY	GRJ	DATE	JUN 20, 1996	FIG. NO.	2

File name: K:\CADD\87X4860D\74860001.DWG Last edited: 96/06/18 @ 13:41



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0 5 10 20

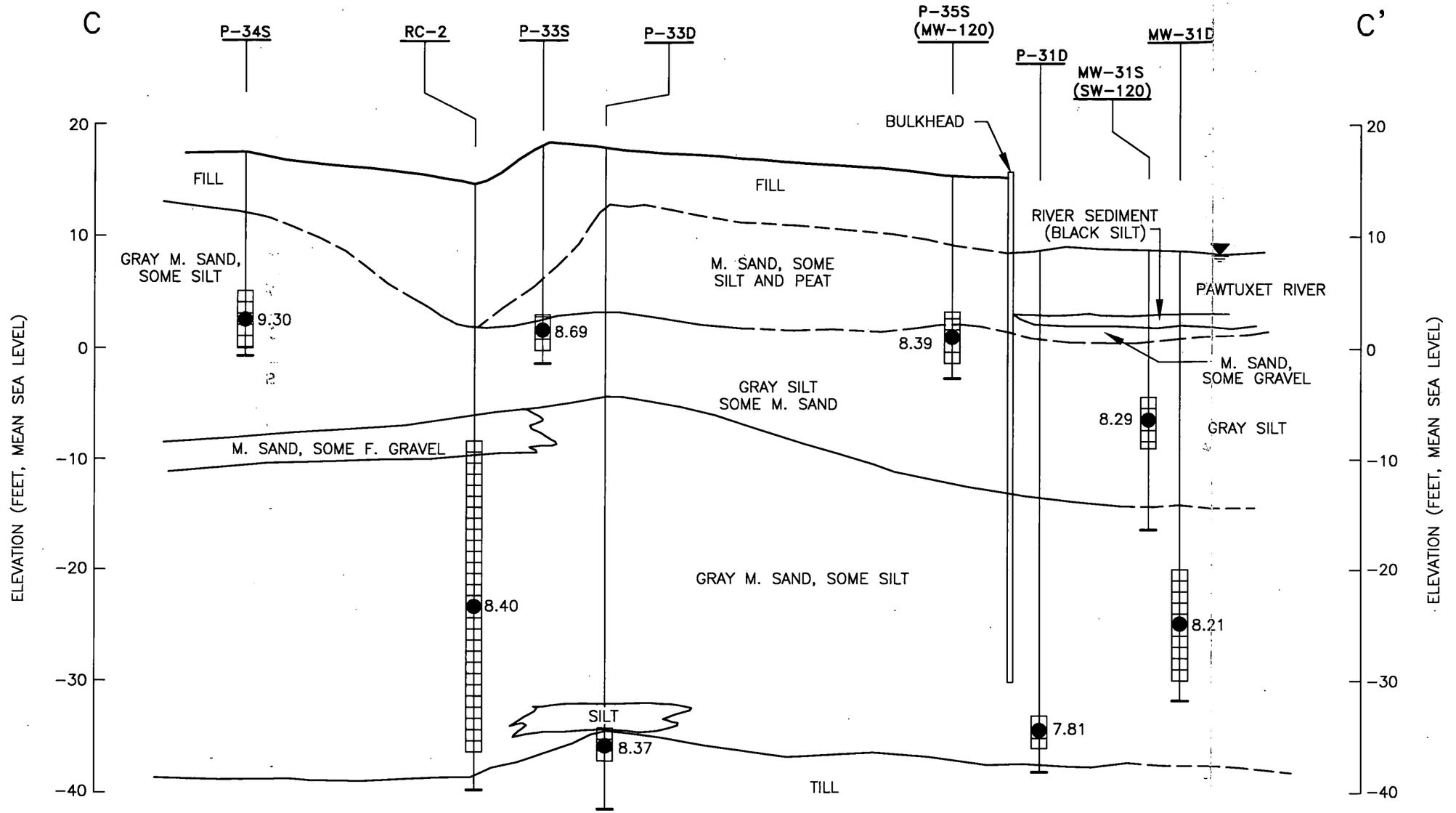
HORIZONTAL SCALE (FEET)
VERTICAL SCALE (FEET)

CROSS-SECTION B-B'
GROUNDWATER ELEVATIONS 10/31/94

WOODWARD-CLYDE CONSULTANTS
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY

DR. BY	FWD	SCALE	AS SHOWN	DWG. NO. 74660002	PROJ. NO. 87X4660D
CK'D. BY	GRJ	DATE	MAY 13, 1996	FIG. NO.	3

File name: K:\CADD\87X4660D\74660002.DWG Last edited: 96/05/16 @ 13:34



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0 5 10 20
HORIZONTAL SCALE (FEET)
VERTICAL SCALE (FEET)

CROSS-SECTION C-C'
GROUNDWATER ELEVATIONS 10/31/94

WOODWARD-CLYDE CONSULTANTS
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY

DR. BY	FWD	SCALE	AS SHOWN	DWG. NO. 74660004	PROJ. NO. 87X4660D
CK'D. BY	GRJ	DATE	JUN 20, 1996	FIG. NO.	4

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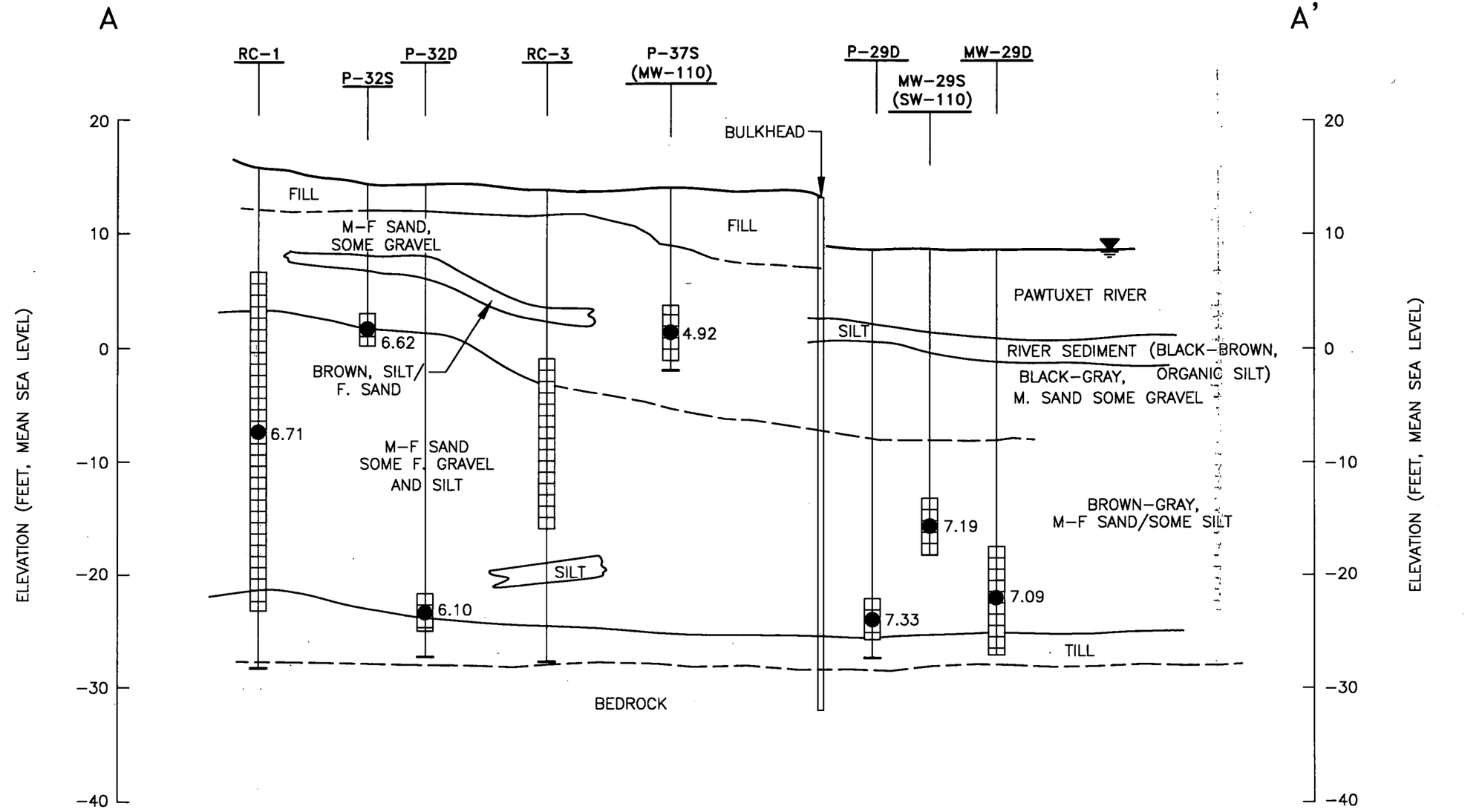

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0 5 10 20

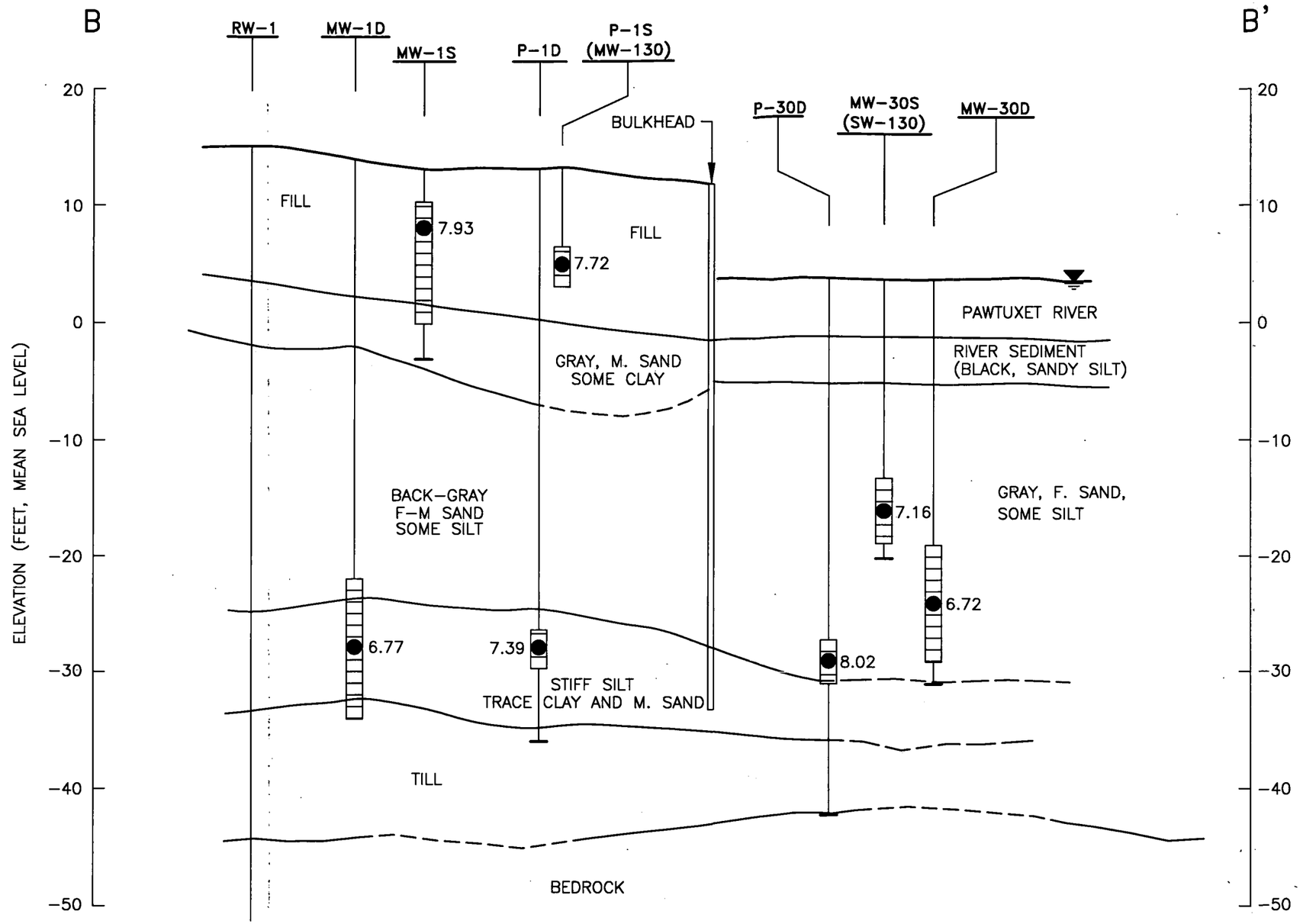
HORIZONTAL SCALE (FEET)
VERTICAL SCALE (FEET)

CROSS-SECTION A-A'
GROUNDWATER ELEVATIONS 3/28/96

WOODWARD-CLYDE CONSULTANTS
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY

DR. BY	FWD	SCALE	AS SHOWN	DWG. NO. 74660006	PROJ. NO. 87X4860D
CK'D. BY	GRJ	DATE	JUN 20, 1996	FIG. NO.	5

File name: K:\CADD\87X4860D\74660006.DWG Last edited: 06/06/20 @ 13:13



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0 5 10 20

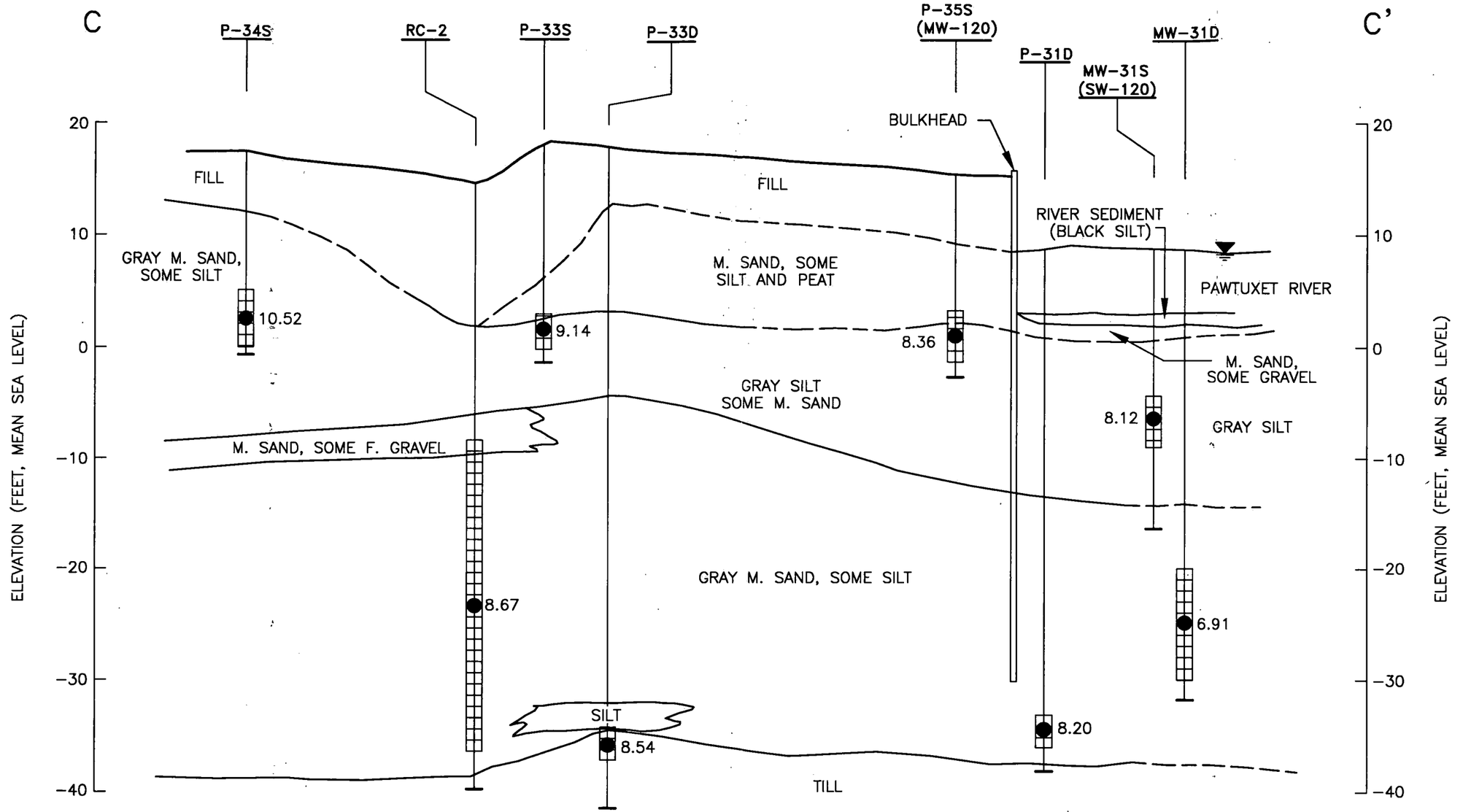
HORIZONTAL SCALE (FEET)
VERTICAL SCALE (FEET)

CROSS-SECTION B-B'
GROUNDWATER ELEVATIONS 3/28/96

WOODWARD-CLYDE CONSULTANTS
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY

DR. BY	FWD	SCALE	AS SHOWN	DWG. NO. 74660005	PROJ. NO. 87X4660D
CK'D. BY	GRJ	DATE	JUN 20, 1996	FIG. NO.	6

File name: K:\CADD\87X4660D\74660005.DWG Last edited: 96/06/20 @ 14:08



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0 5 10 20
HORIZONTAL SCALE (FEET)
VERTICAL SCALE (FEET)

CROSS-SECTION C-C'
GROUNDWATER ELEVATIONS 3/28/96

WOODWARD-CLYDE CONSULTANTS
ENGINEERING & SCIENCES APPLIED TO THE EARTH & ITS ENVIRONMENT
WAYNE, NEW JERSEY

DR. BY	FWD	SCALE	AS SHOWN	DWG. NO. 74660003	PROJ. NO. 87X4860D
CK'D. BY	GRJ	DATE	JUN 20, 1996	FIG. NO.	7

File name: K:\CADD\87X4860D\74660003.DWG Last edited: 96/06/20 @ 13:08